Annual Book Issue

SCIENCE

24 April 1959

Volume 129, Number 33

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Saunders

2 New Texts for the <u>Rigorous</u> General Chemistry Course

Hutchinson — CHEMISTRY: The Elements and their Reactions

New!—This is a superbly written textbook for the intensive freshman college course in general chemistry. It features the deductive approach and is essentially a physical chemist's presentation of the subject. Abandoning the historical approach, the author begins with a modern explanation of the atom, followed by important data on the laws and principles of physics which relate to chemistry.

The first three parts of the book are a rigorous presentation of chemical theory. Frequent references are made to electron orbitals, the chemical bond, and oxidation-reduction reactions. Part 4 discusses, at length, 24 elements typical of the various chemical families they represent.

This new text will be readily understandable to students who have had no previous courses in chemistry or physics.

More advanced portions of the text in small type may be omitted by students for whom the one-year course is likely to be their only formal contact with chemistry in college.

373 helpful illustrations, drawn by the author in 3 dimensional effect, like the one at the right, illuminate the text.

By Eric Hutchinson, Ph.D., Associate Professor of Chemistry, Stanford University. 745 pages, with 373 illustrations. About $8.00. *New!*

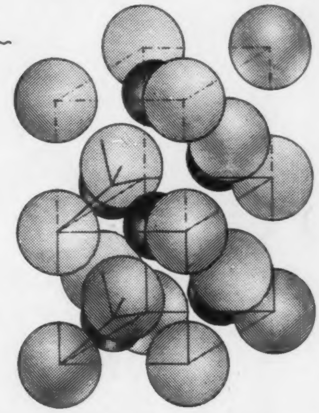


Figure 33-7. The structure of one of the forms of zinc sulfide (sphalerite). Note that in this structure each zinc atom is tetrahedrally surrounded by sulfur atoms, and conversely. Note however, that this structure is distinctly different from that of zinc oxide in Figure 33-6. (This latter is the same structure as that of another form of zinc sulfide, wurtzite.) Note, finally, that the sphalerite structure is very similar to that of diamond, given in Figure 28-2. The wurtzite and sphalerite structure are very common.

Hutchinson — ELECTRONS, ELEMENTS and COMPOUNDS

New!—A shorter version of the text described above. Dr. Hutchinson has provided this volume to meet the needs of solid one year courses where the longer text may be too "heavy". This is an excellent book to provide the beginning student with a comprehensive background in chemistry—giving him all the important principles but not burdening him with detailed mathematical equations. It omits only that information not of vital importance to a general chemistry course. This has resulted in a book about 200 pages shorter. The sequence of topics follows very closely that in the longer text. 290 of the author's excellent illustrations, drawn in the 3-dimensional effect, have been retained. All scale models of molecules and ions have been prepared in such a way that the finished illustrations are 50,000,000 times larger than their real counterparts. The reader, therefore, may make direct comparisons of size. The same emphasis is placed on chemical theory and descriptive organic chemistry as in the larger work. The requirements of both physical and structural chemists are met in this book.

By Eric Hutchinson, Ph.D., About 550 pages, with about 290 illustrations. About $6.50. *New—Just Ready!*

Gladly Sent to College Teachers for Consideration as Texts

W. B. SAUNDERS COMPANY

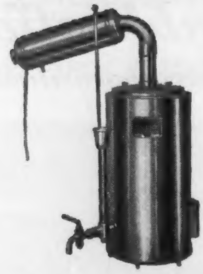
West Washington Square **Philadelphia 5**

SCIENCE is published weekly by the AAAS, 1515 Massachusetts Ave., N.W, Washington 5, D.C. Entered at the Lancaster, Pa., Post Office as second class matter under the act of 3 March 1879. Annual subscriptions: $8.50; foreign postage, $1.50; Canadian postage, 75¢.

Water Purity

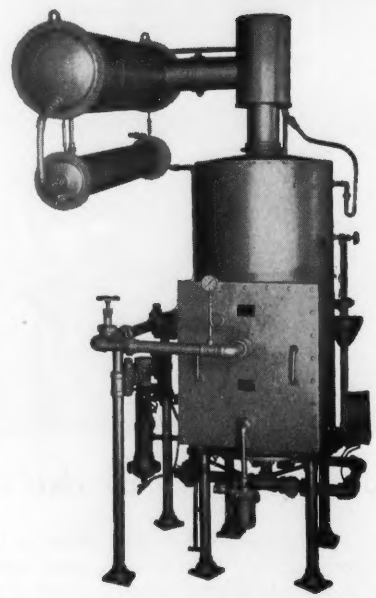
• FOR EVERY NEED •

American Sterilizer WATER STILLS



Typical Laboratory Still: Electric heated. ½ to 10 gallons per hour capacity.

½ to 500 gallons per hour



Typical Industrial Unit: Mass production steam heated Still with automatic controls. 50 to 500 gallons per hour capacity.

- **½ to 500 gallons per hour Evaporator capacity range.**
- **Steam, Electric or Gas heated installations . . . Kerosene or Gasoline heated Portable Units.**
- **Fully automatic or manual controls.**
- **Single, Double and Triple distilling systems.**
- **Storage Tank capacities from 5 to 1000 gallons.**
- **All internal parts heavily coated with pure block tin. Stainless steel, Aluminum or special alloys also available.**

•

Thousands of Amsco Water Stills in laboratories, industrial or processing plants and hospitals throughout the world are producing distilled water of the very highest purity . . . economically, dependably and efficiently.

Whether the distillate quantity is small or large . . . for exacting laboratory experiments, or for mass processing . . . the purity of water is the same, exceeding the standard set up by the United States Pharmacopeia.

Whatever your water conditions or distillate requirements there is an Amsco distilling system especially adapted to your needs. Write for detailed information . . . Bulletin IC-601.

Deionizers . . .

5 to 1000 gallons per hour . . . with cation or anion resin in single bed or dual bed arrangement.

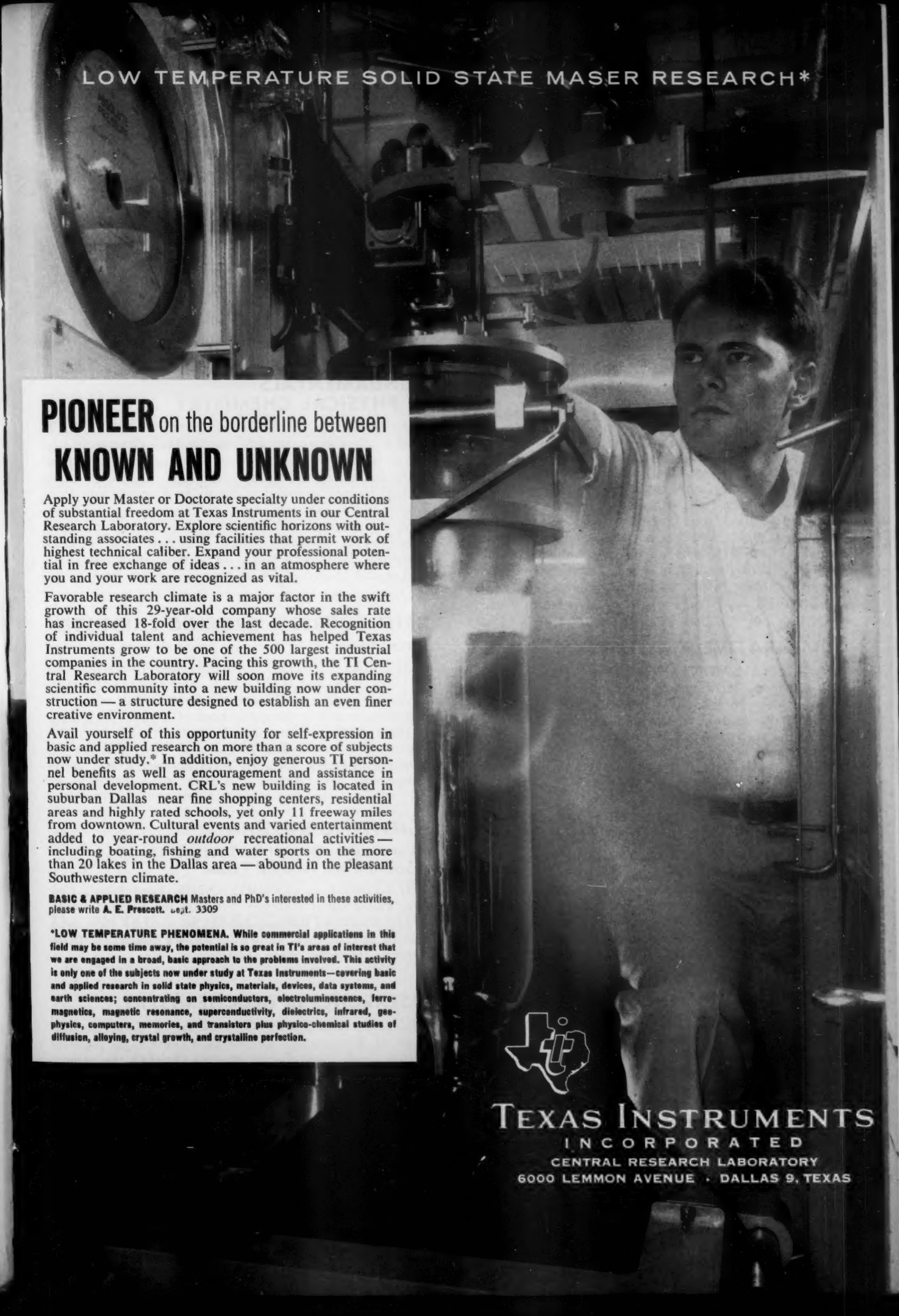
•

AMSCO

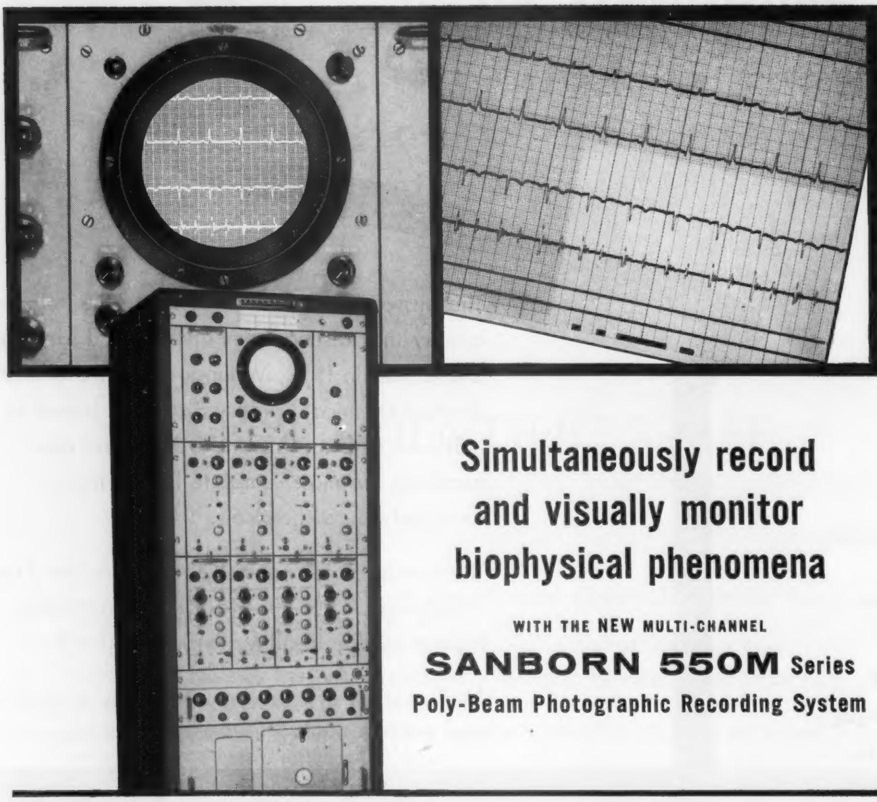
AMERICAN STERILIZER

ERIE • PENNSYLVANIA

INDUSTRIAL and SCIENTIFIC DIVISION



LOW TEMPERATURE SOLID STATE MASER RESEARCH*
PIONEER on the borderline between
KNOWN AND UNKNOWN
Apply your Master or Doctorate specialty under conditions of substantial freedom at Texas Instruments in our Central Research Laboratory. Explore scientific horizons with outstanding associates . . . using facilities that permit work of highest technical caliber. Expand your professional potential in free exchange of ideas . . . in an atmosphere where you and your work are recognized as vital.
Favorable research climate is a major factor in the swift growth of this 29-year-old company whose sales rate has increased 18-fold over the last decade. Recognition of individual talent and achievement has helped Texas Instruments grow to be one of the 500 largest industrial companies in the country. Pacing this growth, the TI Central Research Laboratory will soon move its expanding scientific community into a new building now under construction — a structure designed to establish an even finer creative environment.
Avail yourself of this opportunity for self-expression in basic and applied research on more than a score of subjects now under study.* In addition, enjoy generous TI personnel benefits as well as encouragement and assistance in personal development. CRL's new building is located in suburban Dallas near fine shopping centers, residential areas and highly rated schools, yet only 11 freeway miles from downtown. Cultural events and varied entertainment added to year-round *outdoor* recreational activities — including boating, fishing and water sports on the more than 20 lakes in the Dallas area — abound in the pleasant Southwestern climate.
BASIC & APPLIED RESEARCH Masters and PhD's interested in these activities, please write **A. E. Prescott.** Dept. 3309
***LOW TEMPERATURE PHENOMENA. While commercial applications in this field may be some time away, the potential is so great in TI's areas of interest that we are engaged in a broad, basic approach to the problems involved. This activity is only one of the subjects now under study at Texas Instruments—covering basic and applied research in solid state physics, materials, devices, data systems, and earth sciences; concentrating on semiconductors, electroluminescence, ferromagnetics, magnetic resonance, superconductivity, dielectrics, infrared, geophysics, computers, memories, and transistors plus physico-chemical studies of diffusion, alloying, crystal growth, and crystalline perfection.**
TEXAS INSTRUMENTS
INCORPORATED
CENTRAL RESEARCH LABORATORY
6000 LEMMON AVENUE · DALLAS 9, TEXAS



Simultaneously record and visually monitor biophysical phenomena

WITH THE NEW MULTI-CHANNEL

SANBORN 550M Series

Poly-Beam Photographic Recording System

SPEED and SENSITIVITY of the 550M System permit diagnostically accurate recording of fast changing phenomena such as heart sounds and small-animal ECG's and of low-level signals such as small-muscle myograms, EEG and fetal ECG.

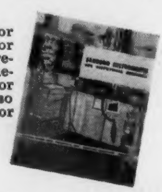
VERSATILITY and FLEXIBILITY of the 550M design offer many advantages. The system can be purchased with only 4 or 6 channels and minus the monitoring unit. Additional *interchangeable* plug-in preamplifiers (up to a total of 8), plug-in mirror galvanometer inserts and the visual monitoring unit – consisting of an electronic switch, vector timer and oscilloscope – can be added later.

ADDITIONAL FEATURES include: entire 6 inch chart width available to all beams... ability of beams to be *superimposed* and to *cross* each other... photographically registered *timing* and *amplitude lines* ... trace interrupter for *beam identification* ... provision for *elimination of amplitude lines* from part or all of the record ... choice of 8 chart speeds from 1.25 to 200 mm/sec ... display on the monitoring unit of up to four waveforms at once, or vector loops, as either a substitute for or a supplement to the recorder ... exposed film container can be removed at any time under normal light ... event marker included ... provision made for remote control ... viewing window permits observing and positioning of galvanometer beams.

The new 550M Poly-Beam is a completely self-contained recording – monitoring system built into a single, mobile cabinet only 22″ wide and 6′ high.

Sanborn also offers a new *direct-writing* recorder, the 350M Series – in a 6- or 8-channel system. Plug-in "350" style preamplifiers can be used interchangeably with the 550M Series which is identical in cabinet size and style.

Write for the new 8-page 550M catalog, or the complete catalog describing the major Sanborn instruments for measuring, recording or monitoring biophysical phenomena. The Sanborn Branch Office or Service Agency nearest you can also supply complete information on any or all Sanborn equipment.



SANBORN COMPANY
MEDICAL DIVISION
175 Wyman Street, Waltham 54, Massachusetts

For accurate measurement of pH

...the

RADIOMETER pH Meter 22

Included in the complete line of famous Danish RADIOMETER Electro-chemical instruments is the pHM 22. This model is a-c line operated and designed for general laboratory use inclusive of electrometric titrations.

Features

- Exceptional stability — no zero drift
- Large mirror scale spreads 14 pH over 11 inches
- Accessory biological meter 6-8 pH on a 6.4" scale
- Accuracy .01 to .05 pH with reproducibility down .002 pH
- 10 Millivolt ranges
- Accurate temperature compensation
- Will perform measurements on grounded media
- Will perform Dead Stop End Point titrations
- Full range of standard and special type electrodes

Applications

- pH determinations and millivolt measurements in the laboratory
- Continuous pH determinations or millivolt measurements
- Acid/base, redox or other potentiometric titrations
- Dead-stop end-point titrations

Descriptive literature on request.

Also available
MODEL TTT1
comprising all the features of pHM22 but designed for automatic titration and batch control. Ask for descriptive literature.

SOLD AND SERVICED IN U.S.A. BY
WELWYN INTERNATIONAL INC.
3355 Edgecliff Terrace CLEVELAND 11, OHIO

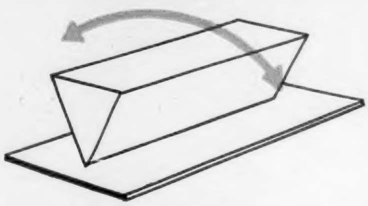
RADIOMETER
72 Emdrupvej COPENHAGEN, DENMARK

In Canada: Contact any Branch of Canadian Laboratory Supplies Limited

THE Mettler PAGE

DEVOTED TO NEWS ABOUT TRULY MODERN BALANCES

PRECISION often referred to as reproducibility... IS THE FOUNDATION on which rests the accuracy of any balance...



Friction between moving parts is always present. It is the friction between knife-edges and planes which is primarily responsible for the dispersion of readings, when the same object is weighed many times on one and the same balance.

Precision has been defined as "the degree of agreement of repeated measurements of the same quantity."

The "standard deviation" calculated from the results of such repeated weighings is the measure of the precision of a balance

$$S = \sqrt{\frac{\Sigma d^2}{f}}$$

Variable loads on knife-edges give variable friction. Precision becomes a function of the weight to be determined.

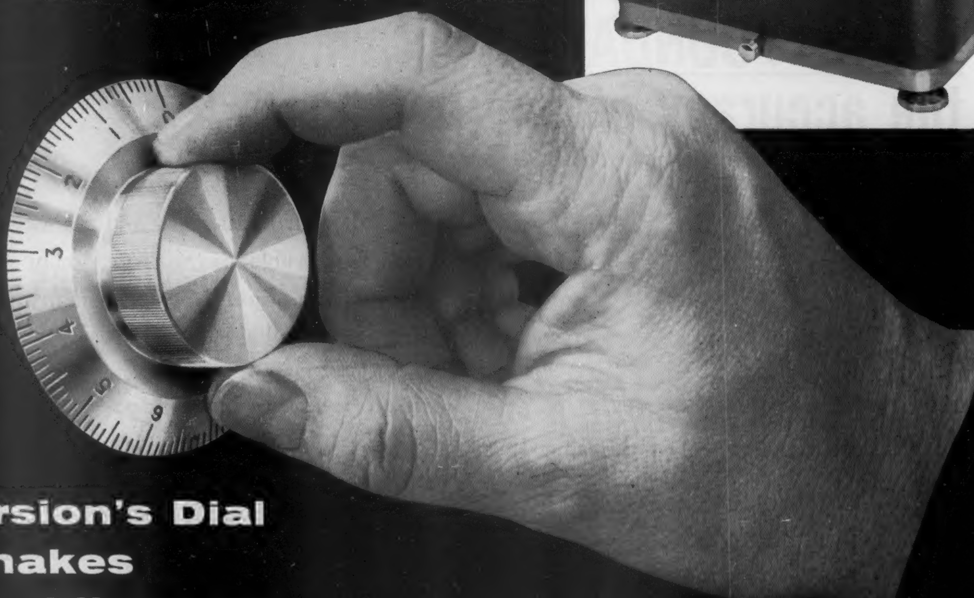
Constant load on knife-edges gives a constant value to the friction and the precision of the balance does not depend on the weight to be determined.

The precision of a substitution balance working under constant load has a well-defined value. As such, it is a firm foundation for the accuracy of the weighing results.

All METTLER balances are substitution balances working under constant load. The precision of these balances can be, and is, clearly stated in our descriptive literature. Write for your copy today.

METTLER INSTRUMENT CORPORATION
BOX 242, HIGHTSTOWN, NEW JERSEY

NEW
Torsion Balance Saves 60% of Weighing Time



Torsion's Dial makes the difference

And what difference it makes! You can now make three times as many weighings per hour as before with Torsion's new Dial Balance. Here's why:

Conventional laboratory balances use a graduated beam and slide weight for "fine" weighing after the weight has been determined with 1 gram. Under the old procedure the balance is arrested, slide weight positioned, balance released, balance comes to rest, position of indicator noted, balance arrested again, slide weight repositioned and so on until the weight is determined within .01 gram.

All this time consuming "cut-and-try" procedure is replaced with a simple graduated dial which can be turned without arresting the oil-damped balance. This means that the time consuming part of the weighing (below one gram) can be "dialed-in"—and in ⅓ the time.

Unconditional Guarantee

In keeping with Torsion's Million-Plus construction, the new Dial mechanism retains its original accuracy after more than a million weighings. That's why Torsion Balance has unconditionally guaranteed the accuracy of the entire Dial mechanism.

Torsion's new Dial Balance is available in two models.

DLT2, shown above, has a capacity of 120 grams, and a sensibility reciprocal of 10 mgs. (10 mgs. moves the rest point one division).

DLT2-1 has the same specifications but is equipped with a scoop for seeds or other bulky material.

For more information contact your laboratory supply house or write us.

The Torsion Balance Company

Main Office and Factory: Clifton, New Jersey • Sales Offices: Chicago, San Francisco

24 April 1959, Volume 129, Number 3356

SCIENCE

SCIENCE, which is now combined with THE SCIENTIFIC MONTHLY, is published each Friday by the American Association for the Advancement of Science at Business Press, Lancaster, Pa. The joint journal is published in the SCIENCE format. Entered at the Lancaster, Pa., Post Office as second class matter under the Act of 3 March 1879. SCIENCE is indexed in the *Reader's Guide to Periodical Literature*.

Editorial and personnel-placement correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D.C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors. For detailed suggestions on the preparation of manuscripts, book reviews, and illustrations, see *Science* 125, 16 (4 Jan. 1957).

Display-advertising correspondence should be addressed to SCIENCE, Room 740, 11 West 42 St., New York 36, N.Y.

Change of address notification should be sent to 1515 Massachusetts Ave., NW, Washington 5, D.C., 4 weeks in advance. If possible, furnish an address stencil label from a recent issue. Be sure to give both old and new addresses, including zone numbers, if any.

Annual subscriptions: $8.50; foreign postage, $1.50; Canadian postage, 75¢. Single copies, 35¢. Cable address: Advancesci, Washington.

Crucial Experiment

By using the entire earth as a laboratory, the Defense Department, in its Project Argus, posed some fresh problems concerning the role of the military establishment in this country's program of fundamental research. Project Argus involved exploding three small atom bombs some 300 miles above the South Atlantic to produce, among other effects, a temporary belt of electrons around the earth. The experiments were carried out last August and September by the Advanced Research Projects Agency of the Defense Department but came to public attention only last month when the *New York Times* published the story and government officials confirmed it.

Since the full circumstances of Project Argus have not yet been disclosed, it is difficult to say much about the effort except that it seems to be a very important contribution to fundamental knowledge and that it has transformed the study of large-scale geophysical phenomena from an observational science to an experimental science. But even without knowing the special circumstances of this particular experiment, it is still possible to show in general terms the difficulties it raises for the conduct of scientific experiments on a large scale.

In the study of the physics of the upper atmosphere, meteorology, oceanography, and other geophysical phenomena, what is sometimes required is not only a great mass of data but also the collection of these data simultaneously at many different parts of the globe. Scientists must make measurements at a number of observing stations on a common schedule and then combine their results. The data of any one observer are useless for purposes of interpretation until they have been examined in conjunction with the data of the other observers. As long as geophysics on a large scale was simply an observational science, no special problems arose concerning the conduct of a cooperative effort. With the new techniques, the situation is changed.

If a military agency conducts large-scale experiments, then, because of its unique security requirements, it has more reason than other agencies to conduct them secretly. And if such experiments are carried out secretly, this can work to the disadvantage of the general scientific community. Thus, observers outside the privileged agency may, without realizing it, be recording man-made disturbances along with phenomena of natural origin. Further, these observers, also without realizing it, may be participating in the experiments, for their data, being public, are available to the group conducting the experiments. Another point is that investigators outside the privileged agency may at a later date recognize—or be advised—that anomalies in their records have an artificial source, but they may be handicapped in attempting to evaluate the records because of insufficient information about the disturbing causes.

To devise arrangements for the conduct of global experiments that can prove satisfactory to most groups of scientists engaged in geophysical investigations is not in principle a hard task, even though the experiments of one group may affect the data gathered by other groups. The search for cooperative arrangements does become difficult, however, when one of the groups conducting such experiments has strong security requirements, and the stronger the requirements the greater the difficulty.—J.T.

24 April 1959, Volume 129, Number 3356 SCIENCE

Permanence in Book Papers

Investigation of deterioration in modern papers suggests a practical basis for remedy.

W. J. Barrow and Reavis C. Sproull

The deterioration of paper in the books of libraries has been a matter of increasingly acute concern for nearly a century. Although sporadic attempts have been made over this period to ascertain the causes of the deterioration and to find means for preventing it, the problem continues to grow. In this article are presented the results of a recent attempt to determine its magnitude and to open some profitable avenues toward solution.

Background

Books, which were once a principal end product of paper manufacture, now absorb only a small fraction [less than 2 percent (*1*)] of all paper production. By far the greater part of this production has very ephemeral uses—in newspapers, shopping bags, shipping containers, towels, and so on. As a result, the qualities of permanence which once were among paper's most important characteristics now take a much lower place in the scale of importance and may, for most uses, be appropriately ignored. The literature of paper technology is enormous, but this literature typically shows little interest in the product beyond the immediate point of its conversion into consumer goods, and a paper technologist who feels completely at home with new paper may be quite nonplussed when confronted with a piece of paper which may be anywhere from 100 to 1000 years old.

At the other extreme are those for whom permanence is still one of paper's most important characteristics—the custodians of libraries and archives. By living with old papers, the members of these professions may acquire a "feel" for them which is lacking in the paper technologist, but they are usually quite naive with respect to the origin of the qualities which they esteem—a naivete which is betrayed in their urgent though uncritical specification of "all rag" content whenever permanence is desired.

Because libraries cannot prescribe the characteristics of the paper which enters their collections but must take what the market affords, it is no wonder that increasingly, since the introduction of the ground wood and chemical wood fiber papers of the last decades of the 19th century, the custodians of these institutions should find themselves piling up mountains of paper only to watch these mountains disintegrate before their eyes. With respect to newspapers, this situation became so acute and concentrated that it has been met to a considerable extent—with concomitant gains in space saving—through the techniques of microfilming; but for the generality of books the problem is more diffused and complex, and microfilming would consequently be so costly and so wasteful, and would impose so many inconveniences, that these institutions have looked for other solutions or—at the very least—for an improvement in the quality of currently used book papers.

These hopes have been largely unrealized through a combination of circumstances; among these the economics of the situation undoubtedly plays the largest part, but there are other factors also. One of these is lack of appreciation of the exact state of affairs with respect to the deterioration of book papers, the rate and extent of such deterioration, the expectations of permanence which may legitimately be held regarding papers in current use, and so on. Still another is the lack of understanding of the real causes of deterioration and the consequent paucity of economically feasible techniques for preventing it.

In the very recent past, even when publishers, librarians, and papermakers have cooperated in efforts to produce a durable book, the lack of understanding of the real causes of deterioration has too often led to failure. For example, when, in 1906, the Library of Congress commenced publication of the important records of the Virginia Company of London which it had inherited from Thomas Jefferson, it arranged for publication on all-rag paper made by one of the country's oldest and best paper manufacturers (*2*). But by 1928 the resulting volumes (the first two of a set of four) were falling to pieces because of an excessive use of aluminum sulfate and rosin in the sizing.

Deterioration in paper—a process which occurs even under storage conditions which are "normal" with respect to temperature, humidity, and cleanliness, and which is distinguished from the impairment resulting from insects, molds, or use—is evidenced by progressive embrittlement, which eventually prevents ordinary handling. Such deterioration is generally ascribed either to the polluted air of cities or to injurious agents introduced into the paper during the course of manufacture. Considerable attention has been given to the first of these factors, and especially to the effects of sulfur dioxide on paper and to its removal from the air of libraries (*3–5*). It has been found that books stored in urban areas are more acid than those kept in

Mr. Barrow is a document restorer and Dr. Sproull is a paper consultant. Both live in Richmond, Va.

rural locations (*4, 5*); in one case the paper in copies of a book stored in cities showed, over a 25-year period, 2 to 9 percent greater loss in folding endurance than copies of the same book held in rural repositories, but the difference seemed to be ascribable to differences of use rather than of storage conditions (*6*). One study, however, indicates that the greatest absorption of acid occurs in the outer edges of the leaves (*4*). Thus, these studies have shown that while removal of acidic gases from the atmosphere is desirable, such gases account for only a small part of the total deterioration. And they do not explain the phenomenon, frequently observed by the librarian who has stored different books under the same conditions for years, that the leaves of 25- to 50-year-old volumes are cracking while those of 300-year-old volumes remain flexible and strong (Fig. 1). Storage conditions could not by themselves have caused the deterioration of the later books. In spite of this fact, far too little attention has been given to identifying and to inactivating or removing the other probable causes of deterioration—agents introduced into the paper at the time of manufacture.

Yet the history of writing materials suggests avenues of inquiry into this matter. Many early materials have shown amazing stability under storage conditions in which most modern papers would last only a few decades. Papyrus, for example, was a principal vehicle of written records from at least 3000 B.C. down to the advent of paper, 4000 years later, and abundant examples survive. While the relation of acidity to the permanence and retention of flexibility of papyrus has not been adequately explored, two very embrittled examples of about 1000 B.C., examined in the course of our study (*7*), showed high acid levels (*p*H 3.8 and 3.9, respectively). From some time before the beginning of the Christian Era, papyrus was (in the West) in increasingly keen competition with vellum and parchment. These were prepared by a lime process from the skin of sheep, calves, and other animals, and it has been conjectured that their excellent lasting qualities (as evidenced in the Dead Sea Scrolls, some of which date from the 1st century B.C.) are due to the presence of residual calcium carbonate from the manufacturing process. These, in general, have lasted much better than their counterpart, leather, whose acidity varies with the method of tanning.

It took paper a thousand years to travel from China to Europe, which it reached only in the 12th century. But well before the end of the Middle Ages it had become the most common material for record-keeping and had outstripped parchment and vellum as the material used for all but the most important permanent records. Linen rags were the principal source of cellulose fiber in the manufacture of the earlier European papers (*8*), and many of these have lasted well. Several investigators (*4, 9, 10*) have found that the strongest early papers are either very slightly acid (*p*H 6.0 and above) or mildly alkaline, and they attribute this condition to the presence of calcium and magnesium compounds. These compounds may have been introduced either during the bleaching of the rag with extract of wood ashes or through washing the rag with water containing bicarbonates of these elements. It is unlikely that lime was used in the preparation of the pulp (though its use would account for the presence of calcium), since such a process does not appear in the literature until much later. Regardless of the source of these compounds, however, they are associated with preservation, while the acid papers of the same period are today either quite brittle or have altogether disappeared.

Confirmation of these clues is afforded by the history of inks. In the course of the Middle Ages the carbon inks were gradually supplanted in the West by iron gall inks. These contained sulfuric acid, as a result of the interaction of ferrous sulfate with oak gall tannins, in varying degrees of concentration corresponding with the very considerable variations in the old formulae (*9*). Highly acid inks have often done considerable damage to paper, even to the extent of eating holes in it (Fig. 2), while the low-acid inks caused little or no damage, and in some cases the alkalinity of the paper was sufficient to neutralize the acid. The damage done to vellums and parchments by these inks was similarly small, due to the high lime content.

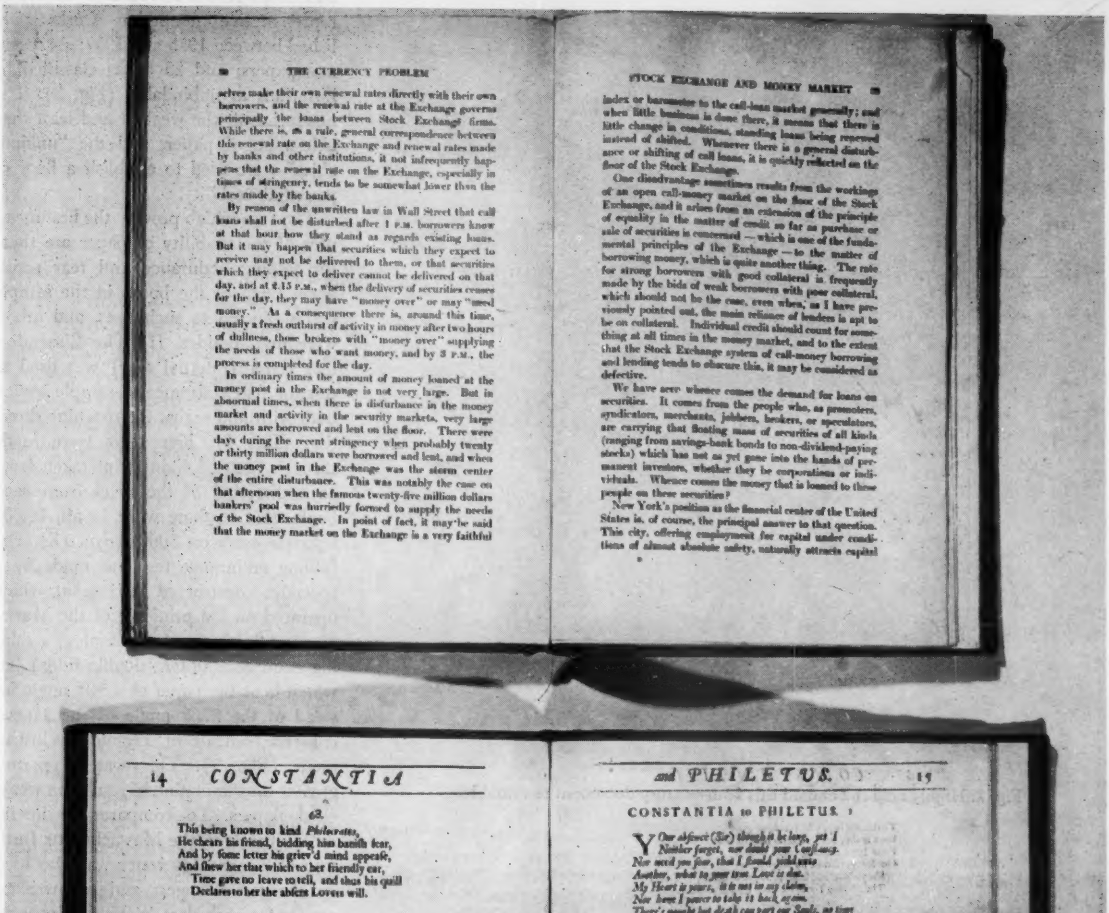
It was paper, as much as any one thing, that made possible the transition from the Middle Ages to the modern world, for it was only through paper that the world could fully benefit from the invention of printing. Printing may, in consequence, be said both to owe its success to paper and at the same time to have ushered in the modern age of paper. Yet there is a certain ironic quality in the observation that this very invention so assisted in stimulating the needs and uses for paper and so advanced the technology by which those needs have been met that it resulted in the progressive loss of that very permanence which it had seemed to insure (*8, 9, 11*).

The use of potassium aluminum sulfate in sizing had already commenced before the end of the 17th century. This was only the first of a number of additives which threatened eventually to shorten the life of paper. Forced by rising demand to resort to less than the best or to other than traditional raw materials, the papermaker found that he could employ weakened rag if he corrected its yellow tint by blueing, and (after 1774) that he could bleach other discolored (and often weak) material with chlorine. Even the relatively pure source of cellulose that became available with the invention of the cotton gin (1793) did not long satisfy the spiraling demand, and the last decades of the 19th century found grass (from 1860) and wood (from 1880) firmly established as raw materials, bringing with them new threats to permanence, either through unwanted constituents of the raw material or through residues or effects of the reagents used to remove such constituents (chlorine, sodium hydroxide, sodium sulfate, calcium bisulphite, and so on).

Meanwhile, as striking evidence of the high degree of stability which a well-made paper can possess and with which the papers of important books and documents should be endowed, every great library can show examples—and in some cases many thousands of examples—of books printed or written five and more centuries ago on paper which is still white, strong, and flexible, though kept under the same storage conditions as books one-tenth as old which have long ceased to be usable.

Physical Strength of Modern Book Papers

In the light of the foregoing facts, it appeared desirable to ascertain, in the first place, just what has happened and is happening to books printed on modern book papers. For this purpose, a representative sample was assembled, consisting of 500 nonfiction books issued by American publishers during the period 1900 to 1949 and comprising 100 books for each decade. None of these books bore signs of having suffered from adverse storage conditions or wear. Three



20 THE CURRENCY PROBLEM

selves make their own renewal rates directly with their own borrowers, and the renewal rate at the Exchange governs principally the loans between Stock Exchange firms. While there is, as a rule, general correspondence between this renewal rate on the Exchange and renewal rates made by banks and other institutions, it not infrequently happens that the renewal rate on the Exchange, especially in times of stringency, tends to be somewhat lower than the rates made by the banks.

By reason of the unwritten law in Wall Street that call loans shall not be disturbed after 1 P.M. borrowers know at that hour how they stand as regards existing loans. But it may happen that securities which they expect to receive may not be delivered to them, or that securities which they expect to deliver cannot be delivered on that day, and at 2.15 P.M., when the delivery of securities ceases for the day, they may have "money over" or may "need money." As a consequence there is, around this time, usually a fresh outburst of activity in money after two hours of dullness, those brokers with "money over" supplying the needs of those who want money, and by 3 P.M., the process is completed for the day.

In ordinary times the amount of money loaned at the money post in the Exchange is not very large. But in abnormal times, when there is disturbance in the money market and activity in the security markets, very large amounts are borrowed and lent on the floor. There were days during the recent stringency when probably twenty or thirty million dollars were borrowed and lent, and when the money post in the Exchange was the storm center of the entire disturbance. This was notably the case on that afternoon when the famous twenty-five million dollars bankers' pool was hurriedly formed to supply the needs of the Stock Exchange. In point of fact, it may be said that the money market on the Exchange is a very faithful

STOCK EXCHANGE AND MONEY MARKET 21

index or barometer to the call-loan market generally; and when little business is done there, it means that there is little change in conditions, standing loans being renewed instead of shifted. Whenever there is a general disturbance or shifting of call loans, it is quickly reflected on the floor of the Stock Exchange.

One disadvantage sometimes results from the workings of an open call-money market on the floor of the Stock Exchange, and it arises from an extension of the principle of equality in the matter of credit so far as purchase or sale of securities is concerned — which is one of the fundamental principles of the Exchange — to the matter of borrowing money, which is quite another thing. The rate for strong borrowers with good collateral is frequently made by the bids of weak borrowers with poor collateral, which should not be the case, even when, as I have previously pointed out, the main reliance of lenders is apt to be on collateral. Individual credit should count for something at all times in the money market, and to the extent that the Stock Exchange system of call-money borrowing and lending tends to obscure this, it may be considered as defective.

We have seen whence comes the demand for loans on securities. It comes from the people who, as promoters, syndicators, merchants, jobbers, brokers, or speculators, are carrying that floating mass of securities of all kinds (ranging from savings-bank bonds to non-dividend-paying stocks) which has not as yet gone into the hands of permanent investors, whether they be corporations or individuals. Whence comes the money that is loaned to these people on these securities?

New York's position as the financial center of the United States is, of course, the principal answer to that question. This city, offering employment for capital under conditions of almost absolute safety, naturally attracts capital

14 CONSTANTIA

68.

This being known to kind *Philocrates*,
He chears his friend, bidding him banish fear,
And by some letter his griev'd mind appease,
And shew her that which to her friendly ear,
Time gave no leave to tell, and thus his quill
Declares to her the absent Lovers will.

The Letter.

PHILETUS to CONSTANTIA.

I Trust (dear Soul) my absence cannot move
You to forget, or doubt my ardent love;
For were there any means to see you, I
Would run through Death, and all the misery
Fate could inflict, that so the world might say,
In Life and Death I lov'd Constantia.
Then let not (dearest sweet) our absence part
Our loves, but each breast keep the others heart;
Give warmth to one another, till there rise
From all our labours, and our industries
The long expected fruits; have patience (Sweet)
There's no man whom the Summer pleasures greet
Before he taste the Winter, none can say,
Ere Night was gone, he saw the rising Day.
So when we once have wasted Sorrows night,
The Sun of Comfort then shall give us light.

Philetus.

69.

This when *Constantia* read, she thought her state
Most happy by *Philetus* Constancy,
And perfect Love; she thanks her flattering Fate,
Kisses the Paper, till with kissing she
The welcome Characters doth dull and stain,
Then thus with Ink and Tears writes back again.

CON-

and PHILETUS. 15

CONSTANTIA to PHILETUS.

Your absence (Sir) though it be long, yet I
Neither forget, nor doubt your Constancy.
Nor need you fear, that I should yield unto
Another, what to your true Love is due.
My Heart is yours, it is not in my claim,
Nor have I power to take it back again.
There's nought but death can part our Souls, no time
Or angry Friends, shall make my Love decline:
But for the harvest of our hopes I'le stay,
Unless Death cut it, ere it's ripe, away.

Constantia.

70.

Oh! how this Letter seem'd to raise his pride!
Prouder was he of this than *Phaeton*,
When he did *Phœbus* flaming Chariot guide,
Unknowing of the danger was to come.
Prouder than *Jason*, when from *Colchos* he
Returned with the *Fleeces* victory.

71.

But e're the *Autumn*, which fair *Ceres* crown'd,
Had paid the sweating Plowman's greediest prayer,
And by the Fall disrob'd the gaudy ground
Of all those Ornaments it us'd to wear;
Them kind *Philocrates* to each other brought,
Where they this means t'enjoy their freedom wrought.

72.

Sweet fair one, said *Philetus*, *since the time*
Favours our wish, and does afford us leave
T'enjoy our Loves, Oh let us not refuse
This long'd for freedom, nor our selves bereave
Of what we wish'd for, opportunity,
That may too soon the wings of Love out-fly.

73.

For when your Father, as his custom is,
For pleasure doth pursue the tim'rous Hare,
If you'l resort but thither, I'le not miss
To be in those Woods ready for you, where
We may depart in safety, and no more
With dreams of pleasure only, feed our fire.

74 To

Fig. 1. Two volumes, printed 227 years apart. The upper one (1908) has a pH of 4.3 and has deteriorated to such an extent that it has a folding endurance of 0 folds; the lower one (1681) has a pH of 5.7 and a folding endurance of 1117 folds.

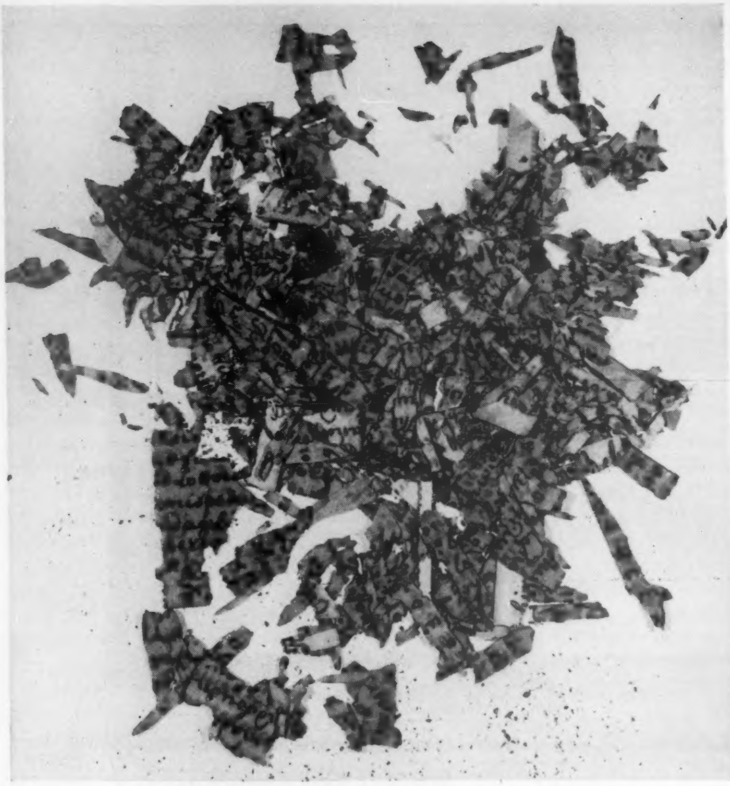


Fig. 2. Highly acid ink caused this 18th-century document to crumble.

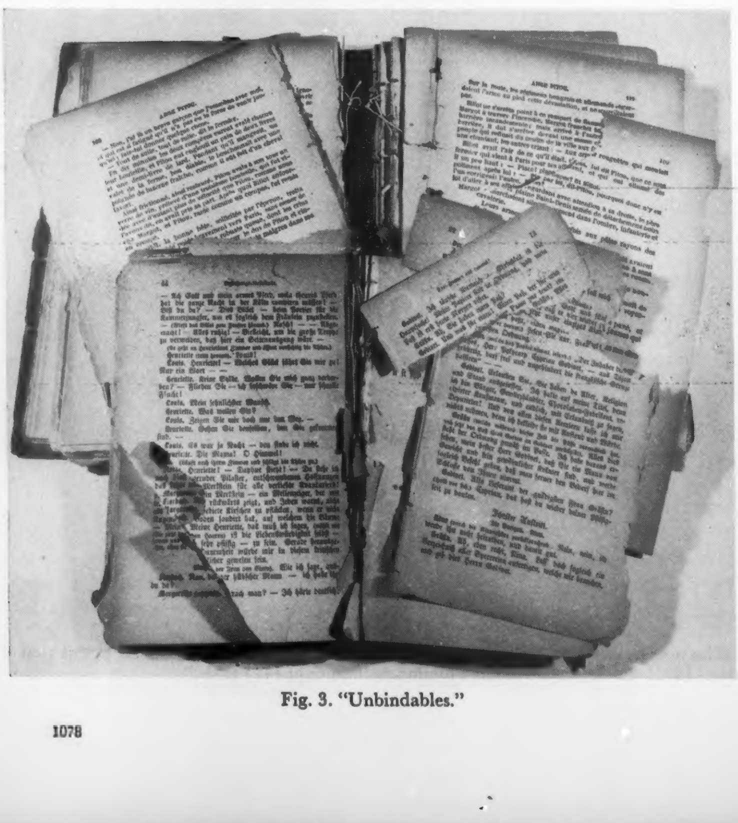


Fig. 3. "Unbindables."

additional groups served as controls: 32 representative nonfiction works published between 1955 and 1957; six recent newspapers; and 25 books classified by librarians as unbindable (Fig. 3). The newsprint, as the weakest and least durable type of paper, and the "unbindables" were used to establish a floor of potential usability.

The tests which provide the best measures of the usability of paper are those for folding endurance and tear resistance. Each of the books in the sample was subjected to such tests, and others were used besides. (i) The Elmendorf tear tester (internal tear) was used to test the tear resistance of sample leaves, both with and across the machine direction (Fig. 4). Five tears were made through each of eight strips taken from each direction of the sheet from each book—that is, there were, in all, 40,000 separate tears on 8000 strips. (ii) The folding endurance test was made by a specially constructed instrument which operated on the principle of the Massachusetts Institute of Technology's folding endurance tester (double folds) but which bent the paper at a 90° angle instead of the 270° angle of the Massachusetts Institute of Technology instrument (Fig. 5). This was to permit greater discrimination of results on weakened papers. To compare the instruments, however, the Massachusetts Institute of Technology tester was also used on the ten strongest and ten weakest papers for each decade. Five strips were taken for the folding test from each direction of the sheet from each book—that is, a total of 5000 strips. (iii) An acidity (pH cold extraction) test was carried out on the same strongest and weakest papers. (iv) The presence of ground wood was determined by the phloroglucinol spot test. All test strips were selected from the center of the leaves and were conditioned and tested in accordance with standards of the Technical Association of the Pulp and Paper Industry. A summary of the results of these tests is presented in Tables 1 and 2 and in Fig. 6.

These results fully justify the concern of the librarian. The median folding endurance of the total sample for the five decades is well below the corresponding figure for new newsprint. Actually 76 percent of the books for the first four decades are below the range for new newsprint (12 to 45 folds) in folding endurance; 17 percent are within that range, and only 6 percent are stronger. If it may be assumed that the folding

endurance of the 1955 to 1957 books (average, 291 folds) is typical of the entire sample when new, it is evident that there has already been a very steep falling off in the books of the 1940 to 1949 decade (average, 106 folds). But the deterioration of the books of this decade has not as yet shown itself sufficiently for full evaluation of its rate or extent.

Acidity may well be the principal cause of deterioration in these papers. Ground wood was found in only 21 of the 500 volumes, and in only six made before 1940, while the role of acidity from other sources is strongly suggested by a comparison of the *p*H values of the weakest and strongest papers (Table 2). In such a comparison it appears that the acidity of the weakest papers is, on the average, from six to ten times as great as that of the strongest. It may be suspected, accordingly, that many of even the stronger papers will continue to deteriorate, since few have a *p*H above 6.0.

The principal sources of this acidity are probably alum rosin sizing, residual chlorides from the bleaching, and a breakdown in some of the oxidizable carbohydrates found in chemical wood fibers. Of course, a small amount may be due to deteriorated cellulose, but failure to wash the chlorides from the fibers and the use of alum in the sizing probably account for most of the acid present.

It also appears from these results that the folding endurance test is the most meaningful for measuring the physical effects of aging. Because a pattern of deterioration similar to that found here, in terms of progressive loss of folding endurance, results from accelerated aging by baking at 100°C [each 72 hours of baking has been found to be the approximate equivalent of 25 years of aging under normal storage conditions (*12*)], the reliability of that method for predicting the permanence of a paper receives additional confirmation.

Stabilization of New Book Papers

It appears both from this and from other studies that in older papers and—as is discussed below—in the newer papers as well, acidity (*p*H of less than 6.0) is associated with deterioration and that mild alkalinity is associated with stability (*4, 5, 9–11, 13–15*). If, then, acidity is a principal enemy of paper, it should logically be expected that stability would be improved through the use of neutralizing agents. Previous investigations (*9*) have shown that the hydroxides and bicarbonates of calcium are effective in counteracting acidity in paper and in stabilizing it under artificial aging tests; further, that the small amounts of calcium carbonate precipitated in paper through soaking in solutions of these compounds appear, upon accelerated aging, to have no ill effects and serve as a buffer for acids which may later be absorbed. However, soaking papers in two solutions seemed to be too

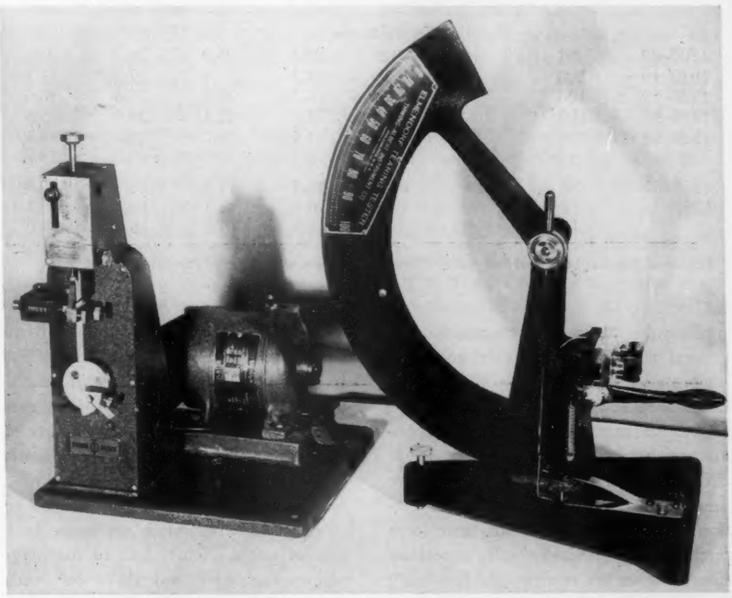


Fig. 4. (Left) The MIT folding endurance tester, used to measure flexibility. (Right) The Elmendorf tear resistance tester, used to measure tear resistance. When the left-hand clamp is moved upward by the swinging pendulum, the paper is torn and the number of grams required to make a continuous tear across the sheet is registered on the dial.

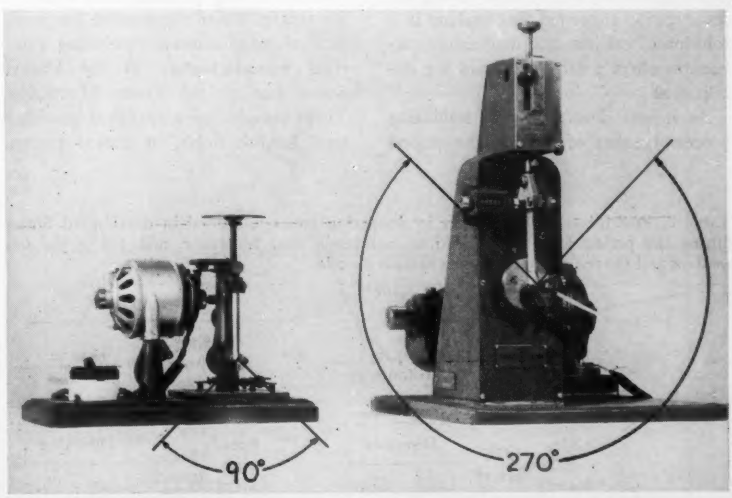


Fig. 5. (Left) The special fold tester used in this study. (Right) the MIT folding endurance tester. In the latter, the paper specimen is fastened first in the upper clamp and then in the oscillating lower jaw. Both ends of the specimen are held tight by screw clamps, and the desired tension is applied. The lower jaw bends or folds the paper at a 270° arc until it breaks; the number of folds is recorded on a counter. The special fold tester operates on a similar principle but folds the paper strip at a 90° arc. This tester is suitable for very weak papers.

Table 1. Present strength of paper in nonfiction books published in the United States during the period 1900–1949.

Period	No. of books	Folding endurance* (folds)		Tear resistance (g)			
				Median		Average	
				Direction in leaf		Direction in leaf	
		Median	Average	Long	Short	Long	Short
			Sample				
1900–09	100	4	12	25.7	25.8	28.2	29.6
1910–19	100	3	9	24.7	22.6	27.2	29.0
1920–29	100	4	8	26.2	28.3	27.6	30.0
1930–39	100	9	51	37.4	42.1	38.6	43.3
1940–49	100	19	106	41.5	44.0	42.0	44.5
			Controls				
1955–57	32	164	291	46.2	49.3	46.2	49.3
1957	6†	24	27	16.1	19.3	16.1	19.3
	19‡	1	3	14.8	15.8	15.0	14.0

* Tension of 1 kg on the special fold tester. † Newsprint. ‡ Very weak (unbindables).

prolonged and costly an operation for general adoption, while calcium bicarbonate alone is not entirely effective because of its low solubility.

Consequently, since magnesium carbonate has characteristics similar to calcium carbonate and is at the same time more soluble, it was thought that a combination of the two in the bicarbonate form might give the desired results, especially since magnesium compounds (probably in the original form of carbonates or phosphates) are found together with calcium in well-preserved old papers—prima facie evidence, at least, that such compounds are not harmful to cellulose (*9*). Preliminary experiments during our investigation suggested that soaking in a solution of calcium and magnesium carbonates offers good possibilities for stabilization.

As it was developed, the stabilizing process consists of soaking the papers overnight in a saturated solution of calcium and magnesium bicarbonates. The bicarbonates left in the sheet after soaking revert upon air-drying to the carbonate form. The solution is prepared by passing carbon dioxide for 2 hours through a solution containing 1.5 to 2 grams of calcium carbonate and 15 to 20 grams of magnesium carbonate in 1 liter of water. Nearly half of the magnesium carbonate and about one-tenth of the calcium carbonate is converted to bicarbonates. After the undissolved particles settle, the clear solution is decanted for use.

Twenty-six reams of different papers commonly used in books were obtained for testing. These represented the products of manufacturers (including principal manufacturers) in the United States east of the Rocky Mountains. These samples were classified as either text, English finish, or coated papers. Comparison was made of the physical and chemical characteristics of specimens of each of these papers, with and without the stabilizing treatment, and both before and after accelerated aging.

For the physical tests the MIT folding endurance tester (double folds) and the Elmendorf tearing resistance tester (internal tear) were employed, since the characteristics tested by these machines are those chiefly involved when the pages of a book are turned.

For the folding endurance test, five consecutive sheets were selected from each ream. Ten test strips were cut from each sheet in each direction; of these five served as controls and five were subjected to accelerated aging. The total of these was 2600 strips. For the tear-resistance test a similar process of selection was employed, except that four strips were taken instead of five; the total of these was 2080 strips. Letter-size sheets were cut from each ream and were subjected to the stabilizing process; the same numbers of test strips were similarly cut from these. The grand total of test strips was consequently 9360. All samples, treated and untreated, were conditioned and tested according to standards of the Technical Association of the Pulp and Paper Industry.

Accelerated aging was effected by heating for 72 hours at 100° ± 2°C, in accordance with the procedure developed at the National Bureau of Standards (*12*). The temptation to use higher temperatures in emulation of certain other investigations, in order to hasten the accelerated aging test, was resisted because it was suspected that these higher temperatures induce a breakdown in the cellulose which does not occur in natural aging.

Exploratory tests were made for copper number, water extractables, alkali solubles, and viscosity; but, though viscosity data exhibited a small trend, they showed no relation to folding endurance or tear resistance, and none of these tests proved satisfactory for evaluating the stability of the papers following accelerated aging, the indications being that chemical tests of this type are not sensitive enough to uncover the subtle changes that are occurring. In addition, however, test specimens were subjected to *p*H measurement, to fiber analysis, and to a spot test with dilute hydrochloric acid to detect the presence of carbonates through the evolution of carbon dioxide. Of all tests, those for folding endurance, tear resistance, and *p*H were found to be the best indicators for

Table 2. Present strength of paper in nonfiction books published in the United States during the period 1900–1949. Folding endurance, tear resistance, and *p*H of the ten weakest and the ten strongest papers of each decade.

Decade	Weakest					Strongest				
	*p*H*	Folding endurance (double folds)		Tear resistance (g)		*p*H*	Folding endurance (double folds)		Tear resistance (g)	
				Direction					Direction	
		Special tester†	MIT tester‡	Long	Short		Special tester†	MIT tester‡	Long	Short
1900–09	4.3	0	0	12.4	14.3	5.3	71	14	40.9	41.1
1910–19	4.2	1	0	13.2	15.6	5.2	29	8	41.9	42.1
1920–29	4.4	1	1	15.2	16.5	5.0	30	10	37.4	36.1
1930–39	4.4	2	2	22.9	27.7	5.1	398	73	55.0	65.0
1940–49	4.4	5	4	26.0	30.0	5.1	530	180	59.4	55.4

* Relative hydrogen-ion concentrations (cold extraction.) † Tension, 1 kg. ‡ Tension, ½ kg.

relating the effects of natural aging to accelerated aging for different papers.

The principal results of these tests are given in Tables 3 and 4, where text papers and English finish papers are differentiated from coated papers and where the samples are arranged in ascending order of relative retention of folding endurance after accelerated aging.

Because it was found that three out of four of the total sample of 532 books (published between 1900 and 1957) tested in the previous investigation were constructed with the machine direction of the paper parallel to the spine, it appeared that the significant tests for measuring the resistance of paper to the strains imposed upon it in the natural use of books are those for folding endurance in the cross direction and for tear resistance in the machine direction. These, in consequence, are the tests reflected in Table 3. Table 4, however, shows retention of the characteristics of physical strength expressed in percentages of average values obtained for both directions of the papers and relates these to the respective *p*H values.

It will be seen from Table 3 that while seven of the text papers and English finish papers, when new, were able to withstand more than 100 folds, after a cycle of accelerated aging only four remained in this category, and that the average drop in folding endurance after a cycle of accelerated aging was from 126 to 58 folds—a loss of 54 percent. By way of contrast, it may be noted that new rag bond papers often survive 3000 folds and that many book papers from 200 to 400 years old can still endure 300 to 1500 folds.

Table 3 also shows what happens to the tear resistance of these papers upon accelerated aging. Two books in the entire sample tore at 30 grams or less when new; after accelerated aging there were eight in this category, and the drop for the text papers and English finish papers (chiefly used for text, in contrast to the coated papers, which are chiefly used for illustrations) was from 54.9 to 42.4 grams—a loss of 23 percent.

The seven coated papers tested showed greater folding endurance but a lower tear resistance than the other two types. It is interesting to note that these papers were found to be mildly alkaline when the entire sheet was ground and tested. However, when they were laminated with cellulose acetate, split into four layers, and delaminated with acetone, the two inside layers were found to be either acid or less alkaline that the two outer layers. This suggests that in coated papers the acidity may be localized. Further work is required to determine the significance of this observation. It is doubtful whether the coated papers will withstand much more wear than the uncoated, because of their low tear resistance.

The fiber analyses on all papers showed that chemical wood fibers were used almost exclusively; rag and ground wood were found only in traces. Hardwood fibers prepared by the sulfite and soda processes predominated, while softwood fibers and the sulfate process were identified less frequently. Thus, the type of chemical wood fiber principally used was itself not conducive to stability.

Again, as with the older papers represented in Tables 1 and 2, the relation of acidity to deterioration is clearly seen in these new papers. Those which showed the highest rate of deterioration following accelerated aging, as indicated by loss in folding endurance and tear resistance, also have the greatest acidity. The three papers among the text and English finish papers which held up best after accelerated aging (samples No. 24, 25, and 26) had the least acidity. Again, it appears that acidity is the principal cause of deterioration, and that it occurs in new papers as well as in old.

None of the 26 papers tested may be considered to have either sufficient original strength or sufficient permanence to qualify them for use in books having a prospect of moderate usage over a long period of time. Under conditions of normal use in libraries, it is doubtful whether they would hold up much better than the 500 volumes tested for the period 1900 to 1949. It may be predicted with some assurance that the high rate of deterioration among most of the new papers will present quite a problem to librarians some three to six decades hence.

So much for the 26 new book papers prior to the stabilizing treatment. These

Fig. 6. Median fold and tear, plotted by decades. Smooth line, fold; dotted line, tear (average for both directions).

Table 3. Principal folding-endurance and tear-resistance data for 26 treated and untreated modern book papers before and after accelerated aging for 72 hours at 100°C. CD, cross direction of the sheet; MD, machine direction of the sheet; ½ kg tension used on all fold-test specimens (MIT tester).

Sample	Untreated				Treated			
	Folds, CD		Tear (g), MD		Folds, CD		Tear (g), MD	
	Before aging	After aging	Before aging	After aging	Before aging	After aging	Before aging	After aging
Text and English finish papers								
1	459	101	101.0	64.2	459	381	103.9	92.6
2	44	18	63.6	41.8	64	53	64.9	64.8
3	275	95	25.8	12.7	263	289	26.6	23.0
4	235	53	76.7	57.2	324	228	79.9	75.4
5	81	39	73.4	52.4	104	116	72.3	71.4
6	384	122	67.6	47.8	401	323	72.7	70.8
8	41	22	43.7	29.8	60	65	40.3	41.8
9	107	50	46.5	31.8	98	101	52.9	48.6
10	57	36	50.4	43.3	94	83	56.2	55.8
12	186	100	53.4	46.6	235	187	61.8	59.0
14	44	32	29.2	21.6	46	38	31.4	29.8
15	59	48	59.4	46.7	99	117	62.3	57.9
16	13	9	33.9	25.8	15	16	31.2	31.0
17	91	63	81.0	72.8	123	88	84.5	76.9
18	17	12	43.9	40.5	26	26	42.2	40.9
22	24	20	50.1	43.8	31	30	48.6	44.6
24	136	126	66.5	57.8	113	124	64.6	58.2
25*	59	63	34.3	29.2	73	57	38.6	35.6
26*	77	89	43.6	40.7	107	88	48.7	45.8
Average	126	58	54.9	42.4	144	127	57.0	53.9
Coated papers								
7	71	29	33.6	28.2	68	39	37.6	32.7
11*	358	186	35.3	30.6	361	395	41.8	37.9
13	315	208	38.9	33.5	414	376	40.2	37.3
19	272	241	26.0	23.8	546	357	31.3	27.8
20	201	156	38.6	18.1	355	317	24.0	21.6
21*	334	271	34.2	30.8	507	368	39.6	36.5
23*	431	316	41.9	39.8	314	278	44.7	45.0
Average	283	201	35.5	29.3	366	304	37.0	34.1

* Spot test indicates presence of calcium carbonate.

Table 4. Relative retention of folding endurance and tear resistance, and *p*H, of 26 treated and untreated modern book papers before and after accelerated aging for 72 hours at 100°C.

Samples*	Untreated				Treated			
	*p*H		Retention of folding endurance after aging† (%)	Retention of tear resistance after aging† (%)	*p*H		Retention of folding endurance after aging† (%)	Retention of tear resistance after aging† (%)
	Control	After aging			Control	After aging		
Text and English finish papers								
1–4	5.0	5.3	26	64	9.0	9.1	86	93
5, 6, 8, 9	5.0	5.0	36	70	8.9	9.0	94	97
10, 12, 14	5.0	5.0	53	80	8.9	9.1	82	95
15–18	5.3	5.3	63	83	8.9	9.0	93	93
22, 24–26	5.8	5.7	92	89	8.9	9.0	92	93
Coated papers								
7, 11, 13	9.4	9.3	50	87	8.9	9.1	86	91
19, 20, 21, 23	9.4	9.2	80	82	9.1	9.2	84	93

* Average of groups of papers. † Average, both directions.

same papers, after being soaked in the solution of calcium and magnesium bicarbonates, exhibited a decided increase in stability. This is seen in Table 3 in their increased retention of both folding endurance and tear resistance following accelerated aging. In contrast to the average 46-percent retention of folding endurance in the cross direction after accelerated aging shown by untreated text and English finish papers, these papers after treatment show 88 percent retention. The corresponding figures for tear resistance in the machine direction are 77 and 95 percent. If the two characteristics of folding endurance (in the cross direction) and tear resistance (in the machine direction) are combined as a general indication of strength, then the retention of the untreated papers is 67 percent and that of the treated papers is 92 percent. Table 4 shows averages of characteristics for both directions.

The sampling procedure upon which this finding is based was computed for the 95-percent confidence level; in consequence, it is believed that errors due to sampling variations have been avoided, and that the percentages of improvement shown have a high degree of reliability.

It is significant, too, that the higher *p*H of the papers after treatment changes little when the papers are subjected to accelerated aging (Table 4). This would suggest that sufficient buffer salts are present to prevent the paper from becoming acidic for many years. (An interesting development shown in Table 4 is the loss of alkalinity of the coated papers following treatment. This may be tentatively ascribed to loss of alkaline compounds from the coatings during soaking.)

Calcium carbonate is used as filler in some modern papers (*14*), and the spot test indicated its presence in two of the text and English finish papers in the sample (Nos. 25 and 26). These proved to be among the most stable papers of the lot.

Comparative Deterioration Curves for New and Old Papers

When batches of the treated and untreated papers were subjected to accelerated aging for 6, 9, 12, and 24 days, respectively (multiples of the 3-day Bureau of Standards procedure), it was found that their decline in folding endurance followed exponential decay curves similar to those exhibited by other

organic materials. The tear resistance followed a similar pattern. Meanwhile, the acidity of the less stable papers was found to increase.

Because the new papers tested during this investigation showed a considerable range in rate of deterioration, it appeared that it might be useful to establish some arbitrary limits to the range, so as to provide measurements with which performances of an intermediate character might be compared. For this purpose, several of the most unstable of the new papers were selected to serve as the floor. For the ceiling, seven old papers (1534 to 1713), still in good condition after 200 to 400 years, were available. Within the range limits set by these papers, the characteristics of the weakest papers, after receiving the stabilizing treatment, can now be observed. All these papers were subjected to accelerated aging, presumptively equivalent to 25, 50, 75, 100, and 200 years of natural aging, respectively.

The results are shown in Fig. 7. The rapid deterioration of the untreated new papers needs no comment. In contrast, the much slower rate of deterioration of even these inferior papers after the stabilizing treatment may be noted as comparing favorably with the rate of deterioration of the very stable old papers.

The plotting on a logarithmic scale of the folding endurance of papers after three or more cycles of accelerated aging (72 hours per cycle) offers the following possible advantages: (i) Relative rates of deterioration may be established which will permit the comparison of a paper with papers of known stability; (ii) estimates of strength properties of a paper may be extended many decades into the future; (iii) irregularities resulting from testing a typically weak or strong portion of a sheet can be detected either in the control or in the artificially aged specimens.

While this method of testing and analysis has been used to check the effectiveness of the experimental stabilizing process, more investigation is needed to explore other relationships between the naturally aged and the artificially aged papers.

Application of Stabilizing Procedure

Practical application of the stabilizing procedure has not been fully developed, but experimental or "trial" runs have been made. The equipment developed is relatively simple and inexpensive. The process can be carried out by a semiskilled person; and the expected production is approximately 2500 pages (6 by 9 inches) per day. Larger sheets and books that present special problems take longer. Bound books must be removed from their covers for treatment and must be resewed, backed, and so on, before recasing. This entails little or no additional expense since many of the books in need of the stabilizing treatment would require rebinding at some future time in any case. Therefore, the cost of the stabilizing procedure for books of lasting value is moderate when compared with the other costs of purchase, cataloging, storing, rebinding, and so on. Since the stabilizing procedure has not presented any major problems, it provides the librarian with a process which will increase several times the life expectancy of the works which he accumulates and stores for posterity.

Summary

Deterioration of paper in the book stock—especially among books of recent decades—has become a serious problem for libraries, but exact measures of the extent or rate of this deterioration have not been available. By the same token, no good indications have been available of the expected useful life of paper in

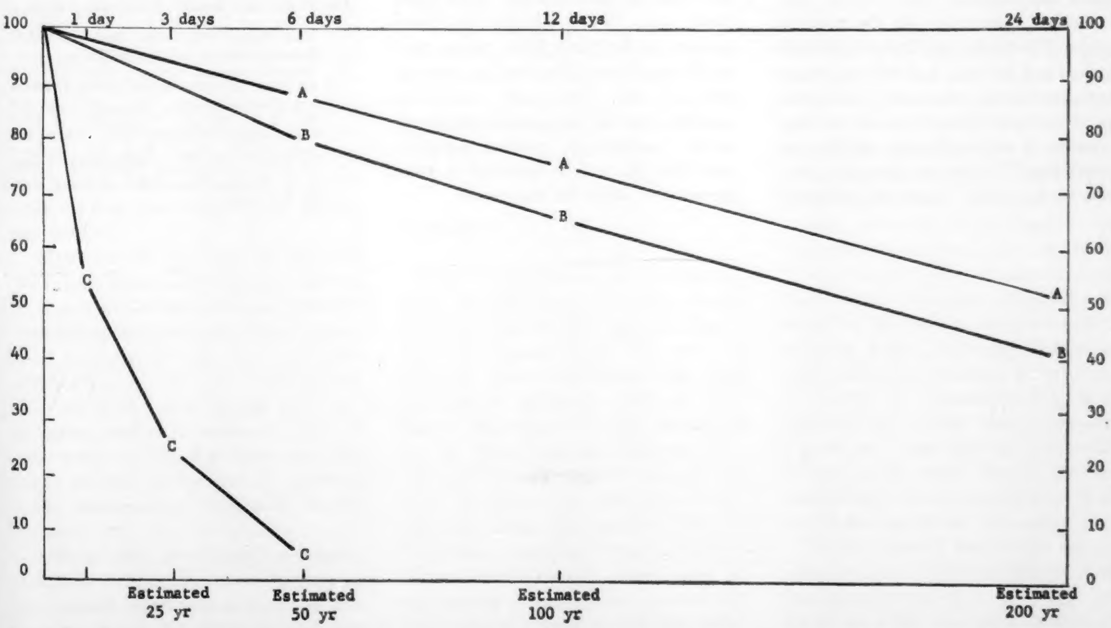


Fig. 7. Retention (percentages) of folding endurance (average for both directions) after heating at 100°C for from 1 to 24 days. *A*, Average for seven old papers made between 1534 and 1713; *B*, average for the papers shown as C after treatment with the bicarbonate solution; *C*, average for six untreated modern book papers with a rapid rate of deterioration.

books currently coming off the press. Furthermore, although attention has been given to means of counteracting one of the recognized causes of deterioration —pollutants absorbed from the atmosphere—similar attention has not been given to the problems of identifying and counteracting the other recognized source of deterioration—agents left in or introduced into the paper at the time of manufacture. Our investigation was undertaken in an attempt to fill some of these gaps in our knowledge.

It has been found that modern books —even those written with a serious or scholarly purpose ("nonfiction") and published ("to last!") in hard bindings —are deteriorating rapidly, and many of those issued 25 to 50 years ago are now almost unusable. The paper of an average American publication of the first decade of this century retains only 4 percent of the folding endurance of a typical new book paper of today; even the paper in the average publication of the 1940's has already declined in folding endurance to 36 percent of today's new book paper.

Meanwhile this typical new book paper itself shows low initial strength (for example, folding endurance on the order of only 20 percent of that of book papers already 200 to 500 years old) as well as indications that it is subject to rapid deterioration.

Acidity appears to be the principal cause of deterioration, both in the older papers and the new. A stabilizing process for neutralizing this acidity was developed and was brought during the investigation to an initial stage of economic feasibility. This process appears to inactivate the most injurious properties found in new book papers and precipitates compounds into the fibers which should, in addition, counteract the effect of pollutants absorbed from the air.

A principal technique used for predicting the durability of paper is the accelerated aging procedure developed by the National Bureau of Standards; by extending the use of this technique, interesting decay curves have been obtained which facilitate comparison of modern papers with papers which have already demonstrated their stability for several centuries. These curves offer other values as well for the study of permanence in paper and suggest that a principle exists relating extended accelerated aging to even longer periods of natural aging than those with which it has hitherto been equated.

During the past 300 years the papermaker has done an excellent job in meeting the demand for more and cheaper paper. A by-product of this accomplishment has been the production of many weak and unstable papers. This does not give rise to any problem where strength or stability are not critical, but where permanence is important, as in libraries of record, the problem becomes serious. While the present study describes a procedure for stabilizing initially unstable paper, much more remains to be done if relatively stable papers are to be made for books of lasting value. There is evidence that this is possible—that such papers can be made from certain types of chemical wood fibers at but little additional cost. But more research is needed, and the cooperation of the scientist, papermaker, printer, publisher, and librarian will be required to assure permanent books for the future.

References and Notes

1. Committee on Interstate and Foreign Commerce, House of Representatives, 85th Congress, "Pulp, Paper and Board; Supply—Demand," *House Rept. No. 573* (Government Printing Office, Washington, D.C., 1957), pp. 38, 66. Total consumption of paper for books is estimated at 10 percent of printing and fine papers, and these papers are shown to have constituted 16.14 percent of all paper and board consumed in the United States in 1956.
2. *The Records of the Virginia Company of London* (Government Printing Office, Washington, D.C., 1906–1935), vols. 1–4.
3. F. L. Hudson and W. D. Milner, *Nature* 178, 590 (1956).
4. T. D. Jarrell, J. M. Hankins, F. P. Veitch, "Deterioration of Book and Record Papers," *U.S. Dept. Agr. Tech. Bull. No. 541* (1936).
5. E. Kimberly and L. Emley, "A Study of the Deterioration of Book Papers in Libraries," *Natl. Bur. Standards (U.S.) Misc. Publ. No. 140* (1933).
6. H. F. Lewis, "Report to the American Council of Learned Societies and the Social Science Research Council," study prepared by the Institute of Paper Chemistry in 1958, unpublished .
7. The studies reported in this article were carried out (by W. J. B.) under a grant to the Virginia State Library from the Council on Library Resources, Inc.
8. D. Hunter, *Paper Making* (Knopf, New York, ed. 2, 1947), pp. 307, 478.
9. W. J. Barrow, *Manuscripts and Documents: Their Deterioration and Restoration* (Univ. of Virginia Press, Charlottesville, 1955), pp. 15, 34, 36.
10. W. V. Torrey and E. Sutermeister, *Paper Trade J.* 96, 45 (1933).
11. M. S. Kantrowitz, E. W. Spencer, R. H. Simmons, "Permanence and Durability of Paper, an Annotated Bibliography of the Technical Literature from 1885 A.D. to 1939 A.D.," *U.S. Govt. Printing Office Tech. Bull. No. 22* (1940).
12. W. K. Wilson, J. L. Harvey, J. Mandel, T. Worksman, *Tappi* 38, 543 (1955).
13. H. J. Plenderleith, *The Conservation of Antiquities and Works of Art* (Oxford Univ. Press, London, 1956), pp. 42, 44.
14. M. B. Shaw and M. J. O'Leary, "Effect of Filling and Sizing Materials on Stability of Book Papers," *Natl. Bur. Standards (U.S.) Research Paper No. RP1149* (1938).
15. National Research Council, *Deterioration of Materials*, G. A. Greathouse and C. J. Wessel, Eds. (Reinhold, New York, 1954), pp. 308, 401; B. W. Scribner, "Comparison of Accelerated Aging of Record Papers with Normal Aging for 8 Years," *Natl. Bur. Standards (U.S.) Research Paper No. RP1241* (1939); E. S. Hanson, *Paper Ind. and Paper World* 20, 1157 (1939).

Wave-Riding Dolphins: How Do They Do It?

At present only the dolphin knows the answer to this free-for-all in hydrodynamics.

P. F. Scholander

One of the thrills of ocean travel comes with the sight of a school of dolphins speeding along through the waves. At more or less regular intervals the animals leap elegantly through the air, often the whole school in unison. These leaps, playful as they often seem, serve in fact their respiratory needs, for while the miniature whales are shooting through the air they complete in a split-second performance their exhalation-inhalation cycle.

Commonly, some individuals will part company with the school just to come dashing to the bow of the ship. An attentive observer leaning out over the railing can watch them speeding along close to the bow, and he may even hear them whistling together, while streams of bubbles escape from the blowhole; but unless already briefed, he is likely to miss the fact that the porpoises just seem to be "standing" there motionless, as if getting a free ride. This puzzling situation was pointed out by Woodcock (*1*), who gave his keen observations in the following words.

"Dolphins in the Gulf of Panama have been seen moving through the sea at a speed of ten knots, their entire bodies showing no apparent swimming motion. This performance was confined, in my observations, to the area immediately forward of the stem (prow) of a seagoing tug and to an estimated depth of one metre or less. Elsewhere near the bow, vertical oscillations of dolphins' tails were readily timed with a stop watch.

"When this 'motionless' swimming was first noticed, the animals were in the normal swimming position. In this position it was difficult to be sure that vertical motions of their tail surfaces were not occurring, since the direction of such motions would be nearly parallel with the line of sight of the observer. However, on several occasions dolphins were seen to turn on their sides during the 'motionless' swimming in such a position that their usual swimming motions would have been normal to the line of sight. No motion was visible in these animals, which were clearly seen just below the surface of the water. One animal remained on its side in this manner for 59 seconds, which represented a distance, at 5.15 m/sec. (10 knots), of 304 meters. At this time dolphins swimming near by used 1.9 tail oscillations per second in keeping pace with the vessel.

"These 'motionless' dolphins seemed to be riding the bow wave (that is, falling down the inclined surface). However, if dolphins are equal in weight to the weight of the water they displace, wave riding is not possible."

Buoyancy

Thus, it becomes necessary to find out about the buoyancy of these animals. Near the surface this depends largely upon the amount of air they carry in the lungs. Like other whales, they dive typically on inhalation and are then lighter than water (*2*), but, as pointed out by Woodcock and McBride (*3*), they have often been observed in aquaria to let out so much air while under water that they sink. The question then is: "Provided a porpoise exhales, will he become heavy enough under water so that he can plane or coast down a 15° wave slope at a speed of 10 knots, maintaining all the while his position in the wave?" It was established at Marine Studios, Florida (*3*), that a 200-pound porpoise, when dead and deflated, sank with a force of 9.2 pounds. The forward component at a 15° angle would amount to only 2.4 pounds, but on the basis of calculations of the drag, it was proposed that this slight force might still suffice for propulsion, provided the flow were laminar; if the flow were turbulent the force would be much too small.

While this explanation seemed severely limited in its application, the problem became even more challenging when Hayes (*4*) proposed that a porpoise would be propelled along in the front slope of a wave even when it was neutrally buoyant. By two different methods of calculating the hydrodynamic forces involved, he came to the conclusion that it is the total weight that matters and not the excess weight, and that the force available for propulsion would therefore be ample to overcome the drag, even if the flow were turbulent. This surprising solution was also given in the following general terms: "A third equivalent point of view is that an immersed body with no excess weight would be acted upon by a force which would give it the same acceleration as the fluid in the same vicinity." The validity of the latter formulation can hardly be doubted (compare the situation that particles accelerated in a centrifuge remain suspended unless they are heavier or lighter than the liquid), but as far as the wave-riding problem goes, this suggests Woodcock's idea rather than Hayes', for the acceleration in the front slope of a regular nonbreaking wind wave consists merely in a slow upward movement of the water. Only in the crest is the orbital movement of the water particles directed forward, but even so, their maximum velocity is only a small fraction of the wave velocity, commonly 10 to 12 percent, and only rarely exceeding 20 percent. In the trough the water moves backward; in the slope behind the crest, downward. If, therefore, one were to tow a streamlined body of neutral buoyancy within the wave, and at the velocity of the wave, one would expect to encounter drag in all positions, but slightly less in the crest than in the trough and an intermediate amount in the slopes—that is, the drag would simply reflect the relative velocities of the object and the water.

This was indeed found to be the case when two such objects of different shape and size were towed in the waves produced by a tug moving at 8 knots. It must readily be admitted that a fair evaluation of all the variables involved would call for rigorous testing in a tow-

The author is on the staff of Scripps Institution of Oceanography, La Jolla.

ing tank, but so far we have been unable to find evidence for the effect predicted by Hayes. It cannot be doubted, on the other hand, that a body sufficiently heavier than water could gravity-plane within the rising water of the front slope (like an aerial glider in an updraft), as suggested by Woodcock, and no doubt the reverse would also be true —namely, that a body lighter than water could "float-plane" within the falling water behind the crest.

Riding the Bow Wave

Whether or not one might find experimental support for these ideas on how to ride wind waves does not matter for our problem, for dolphins do not seem to ride wind waves, but only bow waves, and these are not necessarily identical propositions. On the contrary, it occurred to me, when Woodcock announced his interpretation, that there must be some other solution available, better than gravity-planing, because (i) porpoises regularly dive on inspiration, and are then lighter than water; and (ii) even if they were to exhale under water, the gravity vector for propulsion would be disproportionally small; moreover (iii), it seemed that an alternative explanation was at hand: the porpoise might be pushed forward by the bow wave, simply by putting its tail fluke at an angle into the upwelling water while planing its body horizontally in the ship-course, forward of the bow wave—that is, it would be picking up shear-force thrust with the fluke. This possibility avoids the buoyancy problem altogether and gives a propulsion in principle closely similar to that which the animal employs in a normal downstroke of its tail peduncle, as illustrated by Parry (*5*).

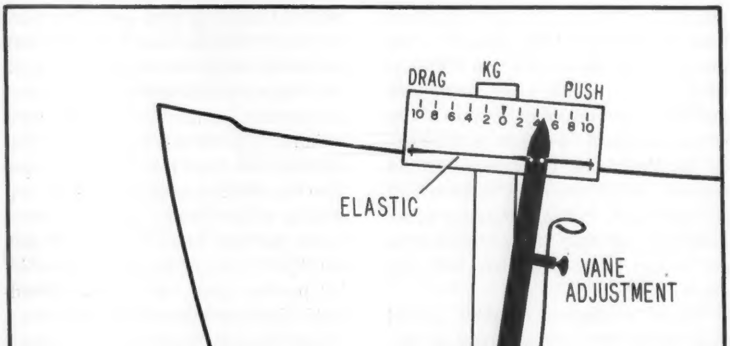


Fig. 1. Schematic presentation of the vane experiment. The relative height of the bow was about twice that shown in the drawing. The contour of an imaginary dolphin riding the bow wave is indicated.

Vane Experiment

While I was cruising in the quiet waters of a West Greenland fjord last summer on board the *M. S. Rundøy,* an opportunity was offered to test quantitatively this, by now, 10-year-old idea. The ship was equipped with a laboratory and machine shop. A streamlined vane was made, 20 by 40 centimeters in area and 4 centimeters at its thickest. It was suspended from a frame which was fastened onto the railing of the bow (Fig. 1). The vane could be clamped at any angle. Drag, or forward thrust, was measured by mounting the vane on a separate board which pivoted on the supporting frame. The board was spring-loaded and calibrated in either direction from a center position.

When the ship was going at 8 knots it was found that, as the vane was slanted downward at a 28° angle from the horizontal, it gave a considerable thrust forward, but on either side of this angle there developed a heavy drag. The forward thrust oscillated in step with the slight up-and-down pitching of the bow, from some 4 to 10 kilograms, averaging 7 kilograms. When we moved the whole gadget midships to a region of horizontal water and reset the vane, the minimum drag of our rather clumsy vane plus the submerged mounting averaged 12 kilograms. A "dragless" vane would accordingly produce a forward thrust of some 19 kilograms, and a real tail fluke of similar size but far more elegantly streamlined would hence be able to produce a thrust of some 18 to 20 kilograms at 8 knots' speed (*6*).

If, therefore, the porpoise, assisted by his pectoral fins, steers himself horizontally and "leans" his tail fluke against the upwelling water of the bow wave, he cannot help but be pushed along with the ship. As the water, in fact, is thrust not only upward and forward but also outward, he may ride keeled over on the side if he wishes. Moreover, as this mode of propulsion does not require that his lungs be empty, he need not take his ride in silence but may whistle to his fellow freeloaders as much as he deems fit. This, I believe, is the way dolphins ride the bow wave, and if it is not, they should try.

This scheme of picking up shear-force

thrust by the tail fluke suggests other possible ways of riding wind waves. If, for instance, the porpoise were cruising in the trough (or crest), he might be propelled along with the wave by sticking the tail fluke into the rising (or falling) water of the slope behind him. He could also combine shear-thrust riding with gravity- or float-planing. Since, however, these smart and playful animals evidently pay little attention to wind waves, this goes to show that none of our proposed ways of riding them can be practical. Evidently wind waves are not steep enough, and do not persist long enough, to do a porpoise much good. Only the abrupt and steep rise of a bow wave seems to be capable of giving him a worth-while push. But how does the porpoise produce the down-thrust of his tail fluke which he obviously needs in order to retain his position?

There appear to be other examples of bow-wave riding in the sea. Cousteau (7), in his book *The Silent World*, describes and shows a photograph of a tiny pilot fish which apparently rode the nose wave of a shark: "A thumbnail of a pilot fish wriggled just ahead of the shark's snout, miraculously staying in place as the beast advanced. He probably found there a compressibility wave that held him. If he tumbled out of it, he would be hopelessly left behind."

References and Notes

1. A. H. Woodcock, *Nature* 161, 602 (1948).
2. P. F. Scholander, *Hvalrådets Skrifter No. 22* (1940); L. Irving, P. F. Scholander, S. W. Grinnell, *J. Cellular Comp. Physiol.* 17, 145 (1941).
3. A. H. Woodcock and A. F. McBride, *J. Exptl. Biol.* 28, 215 (1951).
4. W. D. Hayes, *Nature* 172, 1060 (1953).
5. D. A. Parry, *J. Exptl. Biol.* 26, 24, Fig. 1 and plate 3, Fig. 9 (1949).

6. I wish to express my thanks to L. K. Coachman, O. Iversen, and H. Jensen for help in constructing and testing the bow-wave gadget. This part of the investigation was undertaken in spare time on the Arctic Institute Greenland Expedition 1958, which was aided by a contract between the Office of Naval Research, Department of the Navy, and the Arctic Institute of North America. At Scripps Institution of Oceanography I have enjoyed the benefit of discussions with W. H. Munk, and I had the able assistance of J. S. Kittredge and H. Andersen in the towing tests.

7. J. Y. Cousteau, *The Silent World* (Harper, New York, 1950).

The Forgotten Man: Sir John Lubbock

His contributions to zoology and his liberal record as a member of Parliament ought to be remembered.

R. J. Pumphrey

When Sir John Lubbock, the first Lord Avebury, died in 1913 (before the outbreak of the 1914–18 war) he was deeply mourned by thousands who knew him and revered by millions who only knew of him. By the end of that war his reputation was in complete eclipse, and it is only now and very partially beginning to emerge from an unmerited obscurity.

In a recent number of *New Biology* I found the following passage: "It is remarkable that up to 1914 there was no definite proof that bees could see colours. Everyone from Sprengel onwards had assumed it, but there were only a few experiments such as those of Lubbock (1875–6). These, though suggesting that bees possessed colour-vision, did not eliminate the possibility that they discriminated between different colours by their brightness alone. Indeed, the first full-scale experiments came from Hess (1913) who claimed that this was the case: that honey bees could not see true colours but only various shades of grey. For a time there was doubt, but in 1914 von Frisch began his classic work. . . ."

This is one example of how Lubbock's work is forgotten or, if remembered, described in such a way as to diminish its importance. It is simply not true that von Frisch proved what Lubbock had failed to prove 40 years earlier. Von Frisch does not mention Lubbock in his bibliography, and it may well be that he was only impelled to begin his color-vision work by a distrust of the work of Hess, who started out with a bee in his bonnet and was wrong about most things. Nevertheless, von Frisch's technique resembled Lubbock's very closely, and his results are open to the same sort of criticism. The final answer was given, so far as bees are concerned, not by von Frisch in 1914 but by Kühn in 1927, using pure spectral colors (a method invented by Lubbock though applied by him only to *Daphnia* and to ants). It is worth noting that Lubbock's experiments on bees were supported by extremely pertinent observations on the color sensitivity of wasps and ants, water fleas and dogs.

Lubbock answered contemporary criticism temperately and convincingly. He can hardly be blamed for not replying to the effusions of Hess, which in any case were not published till he was dying. Nothing subsequent should be allowed to obscure the fact that Lubbock was the first by 40 years to do experiments in this field, and that he got answers which, as far as they went, were absolutely right.

Yet, when I took a course in zoology at Cambridge in the twenties, although my pastors and masters spoke highly of the virtues of the experimental method (held by some of them to be a Cambridge invention), I never heard Lubbock mentioned. It is true that I never heard von Frisch mentioned either, and the extraordinary postwar development of comparative physiology in Germany passed almost unnoticed. Until I began to read for myself, I did not realize how much Lubbock had done, not only in his experiments and in pointing the way to further work, but in creating the climate of opinion in which experimental work in biology was possible.

The obscurity into which Lubbock's work relapsed after the 1914–18 war did not, however, cover only his contribution to zoology. He had been eminent, indeed preeminent, in many fields, and

The author is professor of zoology at the University of Liverpool.

This article is reprinted, with permission, from *Notes and Records of the Royal Society of London* [13, No. 1 (1958)].

in all his work seemed to be forgotten. I am not competent to make the reappraisal which is overdue, but it seems worth while to glance, however superficially, at his extraordinary career and to try to guess what qualities of the man and what circumstances of his time account for his success and his failure (if indeed it was a failure).

Boyhood

John Lubbock was born in London in the middle of a significant period in our history, in 1834, just after the great Reform Act, just before the first Factory Act and the accession of Queen Victoria. His birth was in fact roughly synchronous with the birth of the Liberal Party out of the tattered corpse of the Whigs. When he was very young the family moved to Down in Kent. His father was a baronet, a banker of very considerable fortune, a Fellow of the Royal Society, and an eminent mathematician, the first since Newton to battle successfully with the difficult theory of tides. John recorded his own first outstanding memories (from about his third or fourth year) as a glimpse of Queen Victoria's coronation procession and "the sight of a large insect under glass." This early interest in insects remained with him for life, but a much more important event occurred when he was eight. In his own words: "I first heard his name in 1842, when I was just eight years old. My father returned one evening from the City, and said he had a great piece of good news for me. He excited my hopes and curiosity, and at last announced that Mr. Darwin was coming to live at Down. I confess I was disappointed. I thought at least he was going to give me a pony! But my father was right. I little realised what it meant to me, nor how it would alter my whole life."

Friendship with Darwin

Darwin took to the small boy at once and very soon persuaded John's father to give him a microscope. So began a friendship which became only closer with the years till Darwin's death. It was firmly founded on both affection and respect, for, if the young Lubbock venerated Darwin, Darwin himself later confessed that he relied on the opinions of three men only—Hooker, T. H. Huxley, and Lubbock—and of these he put Lubbock first because of "the course of your studies and the clarity of your mind." Lubbock's introduction to scientific discipline was to report on some of Darwin's collections and to help in illustrating his work.

John went to a private school when he was eight and on to Eton at 11. He was removed by his father before he was 15, from motives which seem to have been mixed. Ostensibly and probably quite genuinely Sir John disapproved of the education given at Eton at that time, which consisted of Latin and Greek undiluted by science, mathematics, a modern language, or even English, though history (ancient) and geography (classical) entered into it to a limited extent. But also, he had two ailing partners in the family bank and found that banking was getting in the way of his mathematics. Young John was made a partner forthwith, and with increasing frequency he was left to hold the fort while his father got on with the tides. So he had to face loneliness and responsibility very young, and, with a self-discipline almost incredible today, he set himself to remedy the defects of his education. He organized his day of 17½ hours minutely, beginning with mathematics shown up to his father before breakfast and ending with German from 11 to midnight, because, as he said, nothing else kept him awake so well. It is true that the timetable admitted three-quarters of an hour of whist after dinner and a walk in the afternoon and made ample provision for prayer, meditation, and the reading of sermons. Even so, it is hardly surprising that John's health was at this time thought to be uncertain. It is clear that he had already acquired the faculty of economizing time and of turning from one subject to another without pause or hesitancy which was the marvel of his contemporaries to the end of his life. As he grew up he became bearded in the fashion of the time, but it was probably policy rather than fashion which guided him in this, for, contrary to fashion and in the face of an indignant family, he insisted on wearing elastic-sided boots, remarking that one could easily learn a language in the time saved from doing up laces.

Space does not permit a full survey of his career, but an idea of his multifarious activities may be inferred from the outstanding events of three separate years in his life.

In 1856 (aged 22) he got married; he did the work on the reproduction of *Daphnia* which earned his admission to the Royal Society two years later; and he originated and secured the agreement of all other English banks to a major alteration in banking practice known as the Country Clearing System.

In 1871 (aged 37), within a year of entering Parliament as Liberal member for Maidstone, his first private bill became law as the Bank Holidays Act; his Ray Society monograph on the Collembola and Thysanura was published (he first named the Collembola and distinguished them from the Thysanura); he became a vice president of the Royal Society and president of the Royal Anthropological Institute and was proposed as vice chancellor of the University of London, an office which he held for the next eight years.

In 1888 he served on royal commissions on elementary education and on gold and silver; published what to a zoologist is probably his most important book—*On the Senses, Instincts and Intelligence of Animals*; became a privy councillor and president of the London Chamber of Commerce.

In each of these three years there was an important zoological contribution, but they are not otherwise outstanding in the total of 79.

Success as a Back-Bencher

It is worth looking a little more closely at his parliamentary career. He was Liberal member for Maidstone for ten years and for the University of London for 20 before going to the Lords. He was never a minister and apparently never wanted office. His ambition before entering parliament is on record. It was: (i) to promote the study of science, both in secondary and primary schools; (ii) to quicken the repayment of the national debt; (iii) to secure some additional holidays and shorten the hours of labor in shops.

In another place he admits that he was also at that time anxious to carry a measure to prevent the then rapid destruction of ancient monuments.

In the event, he originated no fewer than 30 private member's bills which became law—all in his life-time except for three which were still on the stocks at the time of his death. A considerable number of these are acts regularizing the law as it affects commercial or professional practice, such as the Bankers Books Evidence Act, College of Surgeons Act, Dental Practitioners Act. The others are more directly related to what we should call "raising the standard of living," and they show clearly how far Lubbock was in advance of his time. Examples are the Open Spaces Act

(1890); the Ancient Monuments acts of 1882 and 1901; the Wild Birds Protection Act (1880); and the Public Libraries Amendment Act (1892).

The way of the private legislator was even then beset by obstacles. It was only too easy for a meritorious bill to be thrown out or talked out for irrelevant reasons, and any serious opposition could block it for years. The Bank Holidays Act, Lubbock's first, got through at once on its title, before opposing interests had time to mobilize. It was never intended as a measure for bank servants only, as its wording makes perfectly clear, but if it had been called a "National Holidays Bill" (which is what it was), it would certainly not have had so easy a passage. His second bill, on Early Closing, was in fact blocked in 1872 and finally got through in pieces after long delay as: (i) Shop Hours Regulation Act, 1880; (ii) Seats for Shop Assistants Act, 1900; (iii) Shop Hours Act (Early Closing), 1904; and (iv) Sunday Closing (Shops) Bill, 1908.

In the early days there really was sweated labor in shops. Many never closed, and the assistants slept under the counter when they got the chance. The first act of the series only succeeded in limiting to 72 hours a week the work of young persons under 17. A 12-hour day may seem to us more than enough for a child, but before the act a 17-hour day was usual, and even 120 hours a week was not unknown. It took Lubbock 30 years of work to get an act with teeth in it on to the statute book, but he was successful in the end. It is of interest that such important features of the welfare state as holidays with pay, and the 40-hour week stem from private motions of a Liberal more than 50 years before a Labour government was thought of.

His record of success as a backbencher has almost certainly never been approached and quite certainly never will be. He stands alone. And the same qualities which made him successful there account for his successes in some other fields; he was known to be absolutely disinterested, and he was a born and also a highly trained conciliator. If two eminent and pig-headed professors had been revelling for years in the sort of quarrel to which academic persons are prone, careless of whether they were wrecking every career and every enterprise within their ambit, Lubbock, and Lubbock alone, could persuade them that their interests were identical and that a common course of action was agreeable to both. And he could do this and still remain the friend of both. This talent became widely known when in 1871 he was called on to heal the breach between the Ethnological Society and the breakaway Anthropological Society. After that, the ambition of any society on the rocks through strife or incompetence, was to get Lubbock for president or treasurer; and in fact he found time to be president of about 25 learned societies, ranging from the Historical to the Statistical, and of about an equal number of commercial associations and government bodies. And he did work of the first importance in reconciliation during and after the industrial disputes towards the end of the century, especially the great dock strike.

The two great propagandists for evolution and natural selection were Darwin's personal friends, T. H. Huxley and Lubbock. And at first it seems odd that Lubbock, who was perhaps the more effective, should be less well remembered. Huxley was a combative spirit who genuinely hated complacent ignorance in high places. His quarrel was not with the Church but with churchmen who presumed to dogmatize without acquainting themselves with the facts. But he enjoyed the conflict, and if he could wipe the floor with a bishop or a canon of Christ Church it made his day; he does not seem to have been aware—perhaps he did not care—that though he usually silenced opposition he made few converts.

Lubbock took no part in these fireworks. As an evolutionist he believed firmly in progress and in human nature. He believed that if the facts were put to ordinary people in a way which

Fig. 1. Sir John Lubbock [From a portrait drawing by George Richmond in the possession of Mrs. Maurice Lubbock]

neither insulted their intelligence nor twisted the knife in their deepest feelings, they were bound to reach the same conclusions that he had reached and to convince themselves of their truth. Experience showed that as usual he was right. He wrote books and they sold by the hundred thousand, edition after edition, and in every language under the sun.

Author

His success is not really surprising, for he had hit on a technique then quite new and very rarely successfully copied since. He took the whole reading public into his confidence, and he never wrote down to it. There is hardly a book of his which could not be suitably read to the family before bedtime and which does not at the same time tell the expert much that he didn't know and suggest things he had never thought of. And he kept it up. From *Prehistoric Times,* published in 1865, to *Marriage, Totemism and Religion,* in 1911, there is hardly a consecutive three-year period in which a book by him, important, influential, and extremely popular, did not appear.

Books on botany, geology, archeology, sociology, and zoology; books on economics and books on scenery; books on the pleasures of life and the history of coins—it seems incredible that books by one man on such varied subjects should be always readable and almost always of substantial scientific value, until one considers Lubbock's special advantages and abilities. He knew everybody who knew anything; he never forgot what he had heard or read or seen, and he kept to the end of his life the sense of wonder and the curiosity of childhood; he saw the relations between apparently unrelated things, and he saw, with the clarity of the successful businessman, the best thing to do next. He was the master of the wide view and the limited and attainable objective.

As an economist he originated no far-reaching and speculative theories, but he was one of the first to see that if economics was ever to be scientific (and he thought it might) it must have facts. It was his insistence on the publication of bankers' returns and every sort of commercial statistics which has been instrumental in giving a later generation of economists the material on which to work. On coins and currency he could write not only as a collector (there were many collectors) but as a great archeologist and as a banker who had sat both on royal and on international monetary commissions.

He was not a great botanist, though he probably knew the flora of Europe as well as anyone of his time, but he could look at the plant world as an entomologist and an evolutionist, and he noticed that things which every botanist then took for granted needed explanation. His were among the first studies on form and function in plants, and he was the first to appreciate and to try to analyze the profound mutual influence of insects and flowering plants on their evolutionary histories.

Zoologist and Entomologist

As a zoologist, he wrote as one of the first to realize that it is what animals do that makes them interesting, and that the whole of classical taxonomy and anatomy and physiology is not an end in itself but an instrument for the understanding of their behavior. He was also the first to appreciate that behavior is only explicable in terms of the information animals receive from their environment. The order of the words in the title of the book I have already mentioned, is significant—*The Senses, Instinct and Intelligence of Animals.*

He was the first, after the great Réaumur, to realize the degree of intimacy necessary between an observer and the animal under observation before the latter's behavior is susceptible of intelligible description. Even Réaumur could not keep ants alive and under observation for more than a few months. Lubbock invented the simple but satisfactory observation nest, which is still standard, in which colonies could be kept under continuous observation for indefinite periods. He himself kept marked workers for seven years and had two queens of different genera which lived for 13 and 14 years, respectively. He was the first to put identification marks on individual insects, which now seems an obvious thing to do, like Columbus and the egg, but it gives him a claim to be the father not only of all sound subsequent work on the social insects but of much of modern ornithology as well. He was the first to work out, with any degree of completeness, the extraordinary life history of the domestic aphids, which overwinter in ants' nests and are literally put out to grass by the ants in the spring.

He was the first to use a maze as a device for the study of learning by animals, a method which has since been very extensively developed in the United States for testing the learning ability of vertebrates as well as invertebrates. He was the first to use the method of training which the Germans call *Dressur* as a test of sensory discrimination. This is the method which von Frisch has so successfully reinvented and exploited in the work of his school on the hearing and vision of fish and the smell and vision of bees.

He first discovered that the path followed by ants depended, in certain circumstances, on the angle from which light was falling on them and could be changed in direction quantitatively by moving the light source. This effect, rediscovered and christened the "*Lichtkompass* reflex" by Santschi (1911) 40 years later, is basic to all subsequent studies of sun-navigation by insects and birds. And he refers, in parenthesis in his work on color vision, to an observation which anticipates the work of Hertz on form vision in the thirties of this century.

The Peckhams, a pair of distinguished American entomologists, seem to have appreciated the importance of Lubbock's discovery of the light-compass reflex and accord him priority, but they make the singularly stupid reflection that it was a purely chance observation. If it was just chance, then it was just chance that Lubbock, on a walk before breakfast with Charles Kingsley, found the first fossil musk ox to be recorded in Britain and drew from this find the conclusion that the river gravel containing it was laid down in a glacial epoch. It was chance that led him on holiday in Switzerland to find an Eocene fossil in beds then supposed by Swiss geologists to be Triassic and unfossiliferous. It was chance that on another holiday he found a parasitic wasp which uniquely uses its wings to swim under water.

It was chance that he should find, in the rubbish of his own garden, an animal which he called *Pauropus*—an animal then new to science and still of questionable status, though Lubbock's guess that it is a primitive sort of centipede is perhaps as good as any.

It was chance which enabled him to buy up Avebury, the finest megalithic monument in Europe, under the nose of the speculative builder who was proposing to wreck it, and to put a spoke in the wheel of the London and South Western Railway Company when they intended to build a branch line through Stonehenge.

It was chance that led him to Halstatt at the moment when the working of the salt-mines by the Austrian Government was beginning to expose the richest burials and cremations of the early Iron Age known in Europe. (It was, incidentally, Lubbock who first clearly distinguished the hunting Paleolithic from the agricultural Neolithic cultures and gave them these names, which are still standard today.)

If these were all chances, they were not the sort of chances which happen to ordinary people. But of course they were not chance at all. The animal which he named *Pauropus* had probably been seen by others and dismissed, if it was thought of at all, as the larva of something else. This was the natural thing to do, for zoologists had too frequently been caught out in giving generic or even family rank to larval forms of animals already well known as adults, and they were learning caution. But Lubbock had enough knowledge to be sure that there was nothing it could be the larva of, and enough curiosity to examine it carefully and show that it was sexually mature.

Only once does he seem to have been caught napping. Towards the end of his life he was invited, with other distinguished persons, to inspect the recently "discovered" Piltdown skull, and he expressed a definite opinion about its age and importance. In his defense it must be said that he was old, he was ill, and he was fooled in very good company.

Eclipse

How was it possible that such an extraordinary man should have been forgotten so completely? Some reasons can be confidently given. The first world war effected a far more complete break with the past than the last. In the twenties everything Edwardian and Victorian assumed a haze of unreality, even for those who were born before the turn of the century. Even to his contemporaries Lubbock had seemed a little incredible; to the postwar world he naturally appeared entirely fabulous. The class from which he came—the class of the fairly affluent whose sons had filled the professions and the public service as a matter of course, and which could afford to act from principle rather than for monetary advantage—was extinct; the men of military age were dead, and the women of necessity married elsewhere. For that class had predominantly provided "officer material," and the half-life of junior commissioned officers in the 1914–18 war was only a few weeks. So government, local as well as central, passed into the hands either of the spivs, who had done very nicely out of the war, or of people doubtless well-intentioned but untrained and unprepared for that sort of responsibility. To neither did Lubbock seem to provide a satisfactory working model. He might truthfully have been described as an efficient idealist, and the Labour party, then as now, distrusted efficiency almost as much as the Tories distrusted idealism. He had been, if anything, a Liberal, and Lloyd George was busily engaged in the assassination of the Liberal party. He had been an internationalist, and President Wilson was sowing the dragon's teeth of "legitimate national

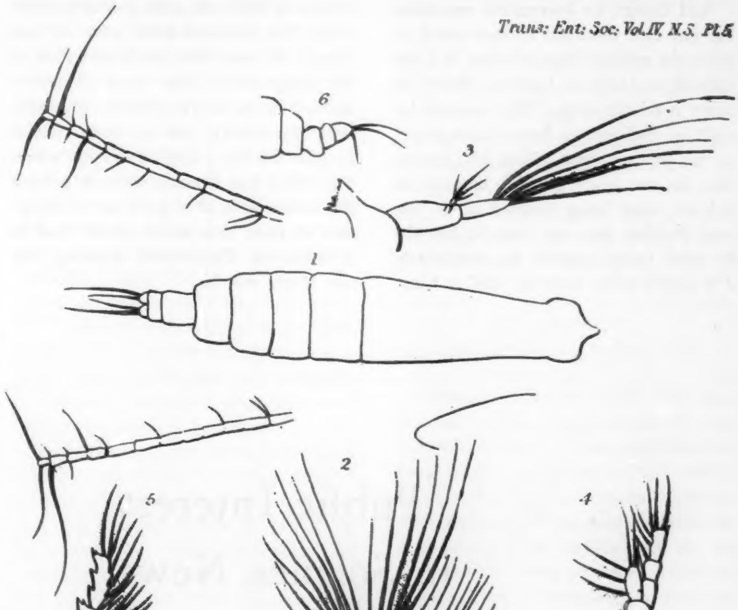


Fig. 2. One of 12 plates illustrating Lubbock's paper "On some Entomostraca collected by Dr. Sutherland in the Atlantic Ocean, *Trans. Entomol. Soc.* 4 (n.s.), pt. 2, 1 (1856). Each plate is subscribed "J. Lubbock, del^{t}. et sculp^{t}." and shows Lubbock's early mastery of the technique of steel engraving.

aspirations." As a banker he was naturally suspected of underhand skullduggery, and if no skullduggery could be detected, that only showed how cunning he had been. As a scientist he was clearly the rankest of amateurs, and science was becoming more and more professional. No one, it was obvious, could possibly have done all the work which appeared in his name. There was something rotten somewhere. It was better to forget him, to depreciate him, or to laugh at him.

And though no journalistic muckraking has ever disclosed enough muck to make the smallest item of news, it is not difficult to laugh at Lubbock. Even his name is faintly comic. With unusual insight he had written home from school at the age of eight telling his parents that he was quite popular because he did not mind being laughed at. It was true. Neither then nor later in life did he mind being laughed at, particularly if it served some cause he had at heart (though he was never so discourteous as to laugh at others unless he knew they were trying to be funny). He incurred a good deal of mirth among his contemporaries (including Ruskin) by giving in an address to a working men's college (and subsequently publishing) a list of the "100 Best Books." Such behavior seems to us both pompous and funny, especially in an eminent Victorian who had never been to a university and could hardly be supposed to know. And to cite it became the stock method of disparagement. But Lubbock knew what he was about. He was very rarely mistaken in his judgment of the state of public opinion or in his recognition of a business opportunity, and he knew that if he gave his list enough publicity, someone would find it worth while to publish the books on it at a price the workingman of those days could afford. And so it happened. Figuratively speaking, the last laugh was his.

Service in Many Causes

So I do not think Lubbock can be said to have failed. Though he was human enough to enjoy the honors showered on him in his life-time, he never sought fame for himself and would not have been distressed if it had passed him by. Of him, as much as of any man, it can be said: "If you require a monument look about you." The results of his life are unmistakably there—in science, in education, in the preservation of the countryside, in the less seamy aspects of the welfare state—and if others now get the credit, he would not have minded.

Perhaps the last word may be left to the late Aga Kahn, who, writing to congratulate him on his peerage, said: "You have touched life at many points, done good service in many good causes and made wonderful use of your life and opportunities. Nor is it a light thing to have made no enemies."

Public Interest in Science News

Two surveys show a direct relationship between science education and assimilation of the news.

Hillier Krieghbaum

A typical American adult is curious about what scientists are doing, and despite the obvious difficulties of popularizing science information, a considerable portion of the general public is, at least, aware of the more dramatic activities of contemporary science.

These conclusions may be drawn from two recently released public opinion surveys made for the National Association of Science Writers, an organization of approximately 350 professional journalists, and New York University, which administered a substantial grant from the Rockefeller Foundation to finance these projects. Both surveys were conducted by the Survey Research Center of the University of Michigan.

The first of the public opinion surveys was made in the spring of 1957, among 1919 adults, to ascertain their responses to various media of communication and their attitudes toward science and scientists. The second was made a year later, in the spring of 1958, and included sampling of 1547 persons. Thus, the two surveys provide a comparison of habits and opinions for periods approximately six months before and six months after the launching of the first satellite, sputnik I.

Here are some findings that illustrate the potential curiosity about science. Two out of five newspaper readers (41 percent for both surveys) reported that they read *all* the medical and health news in their papers, and almost a third (30 percent in 1957 and 32 percent in 1958) said they read *all* the nonmedical science items. Of those interviewed in 1957, two-fifths (42 percent) wanted newspapers to print more medical news and a quarter (28 percent) wanted more space given to nonmedical science news. The question on this preference was not asked in 1958. Two-thirds of each sample (66 percent for 1957 and 62 percent for 1958) were willing that some other news should be eliminated in order that space might be provided for additional science news.

These surveys establish, probably for the first time on a carefully controlled basis of public opinion sampling techniques, that a national audience is waiting for and interested in news items that tell about developments in science. The Survey Research Center used generally accepted techniques of probability sampling, and the size of both samples insures a highly accurate reflection of the habits and opinions of adult Americans.

The amount of science news that was read was impressive, not only in itself but also in comparison with other categories. Only two groupings—"local events" and a human interest grouping for "people in the news"—ranked higher than medical and public health stories

The author is chairman of the department of journalism, communication arts group, New York University, and chairman of the Surveys Committee, National Association of Science Writers.

among the "reads all" percentages in both surveys. Nonmedical science items were close behind, in fifth place before the launching of the first satellite and in fourth place for the second poll. Nonmedical science surpassed the comics in postsatellite appeal.

In both surveys, medical and nonmedical science categories each had greater reader appeal than such categories as national politics, foreign events, sports, and society. As for society news, with its strong orientation for female readers, even the lower-ranking, nonmedical science ranked more than twice as high in "reads all" percentage. When women were asked what news they would give up to make more room for science news generally, one woman in eight (13 percent) was willing to cut space from society news. Twelve percent of the men would curtail news of sports for the same purpose.

Areas of Interest

What are the areas of greatest interest in science from the standpoint of the general public?

Interviewers from the Survey Research Center asked each person in the 1957 sample to recall, if possible, some science items that he had recently read in the press, heard on radio, or viewed on television. Three quarters (76 percent) could recall at least one specific science or medical news item.

Since medical stories generally were more popular than nonmedical science, it should surprise no one to learn that the major killing diseases were mentioned most frequently. They get the bulk of space in print and considerable time on radio and television. Heart disease, which is the leading cause of death in the United States, was mentioned by 32 percent of the newspaper readers, 11 percent of the television viewers, 10 percent of the magazine readers, and 2 percent of the radio listeners. Cancer, the second leading cause of death, was cited by 31 percent of the newspaper readers, 6 percent of the magazine readers, 3 percent of the television viewers, and 2 percent of the radio listeners. Poliomyelitis, or infantile paralysis, which has received wide publicity because of Jonas Salk's vaccine, was mentioned by 20 percent of newspaper readers, 6 percent of magazine readers, 4 percent of radio listeners, and 1 percent of the television audience.

Mental illness, which fills approximately half the country's hospital beds, was cited by 5 percent of newspaper readers, 4 percent of television viewers, and 3 percent of magazine readers. It was all but omitted by radio listeners. Tuberculosis was mentioned by 3 percent of newspaper readers, and the recently much-discussed tranquilizers were cited by 2 percent of newspaper readers. Users of other media largely ignored both these latter topics.

One may conclude, on the basis of these statistics, that the medical stories recalled by most of the public center around a few well-publicized diseases.

Among the nonmedical science news items, an omnibus classification of technology, or the whole spread of practical utilization of scientific research, was remembered best by all but television viewers. Figures for those who recalled news items on technology were as follows: newspaper readers, 25 percent; magazine readers, 15 percent; radio listeners, 11 percent; and television viewers, 7 percent. For recall of news about atomic energy, the statistics were: newspaper readers, 22 percent; magazine readers and television viewers, 8 percent each; radio listeners, 4 percent. Ten percent of the audience for each medium, with the exception of radio, recalled items dealing with so-called "pure" science and research in such fields as physics, astronomy, biology, physiology, exploration, and the social sciences. The fact that this was true for television viewers would be impressive indeed except for the additional fact that 8 percent of the entire sample reported that they were viewing science programs when actually they were tuned to telecasts that could be described accurately only as science fiction. Although there are dangers in generalizing, this latter statistic would seem to indicate less sophistication among television viewers, generally, than among audiences for other media.

Media

For most Americans, the newspapers remain the most popular source of science news and general news. The mounting popularity of television in recent years has manifested itself primarily in the field of entertainment.

Table 1 shows the way in which respondents in the 1957 survey rated the four mass media. Noteworthy in these statistics is the sizable percentage (21 percent) of the public who cite magazines as their favorite source of science news. This is not true for anything like one-fifth of the total sample for either general news or entertainment. Dependence on magazines for science news increased with increase in level of education; 43 percent of those who had gone to college said their main source of science news was the magazine.

Table 1. Results of a survey made in 1957 to determine how respondents rated the four mass media. Number in sample, 1919.

Medium	Favorite for science news* (%)	Favorite for general news (%)	Favorite for entertainment (%)
Newspapers	34	57	5
Magazines	21	4	6
Radio	3	16	14
Television	22	22	74

* Seventeen percent did not mention science news at all.

"Touchstone" Areas of Information

When one turns to consider the public's information about science, he may concentrate either on the public's sometimes vague, sometimes astute, awareness of what is going on or on how much outright ignorance prevails. Certainly the mass media do a highly inefficient job of communicating technical details of science. Few communicators, however, would claim this as even a tangential responsibility of the press, of radio, and of television. In most cases, if such details are communicated, it is a gratuitous accident.

In an effort to ascertain what the public knew about several topics that had been in the news reports of science fairly recently, the 1957 interviewers probed around four "touchstone" areas. All four had been widely discussed in newspapers and magazines and on radio and television. Questions in the "touchstone" sections of the survey were these: (i) "Do you recall hearing anything about the vaccine for preventing polio (infantile paralysis)? What was it that you heard?" (ii) "Have you heard anything about plans to launch a space satellite, sometimes called a man-made moon? From what you've heard, what is the purpose of launching these space satellites?" (iii) "Have you heard anything about radioactive fallout or dust from atomic bombs? As you understand it, what is radioactivity like?" (iv) "In some places around the country fluorides are now being

added to the drinking water. Have you heard anything about that? What do you think is the purpose of adding fluorides to the drinking water?"

To summarize the findings, less than one American in 11 (8.7 percent) was unaware of at least one of these topics. Forty-three percent had some knowledge either of three or of all four of these subjects, and nearly twice as many knew about all four (16.7 percent) as knew of none of them.

What segments of the public were best informed? Men recalled more information than women. By age groupings, the information level rose quickly to a plateau and remained fairly constant from the late 20's through the late 40's. The best informed groups were those in the late 20's and the late 30's; the least well informed were those past 65. A strong positive relationship between education and information exists. For example, one person in 20 (5 percent) among those who never got beyond grade school knew something about all four topics, but more than a third (39 percent) of those who went to college were aware of all four subjects. Thus, deficiencies in education, rather than age, probably accounted for the generally poor showing of those past 50.

Possibly the most significant finding (significant because it offers a clue for future action) was the direct positive relation between science education and the ability to recall information about all four "touchstones." Of those who could "play back" at least some information about all four of these subjects, 78 percent had taken at least one science course in high school and 30 percent had studied some science in college. In fact, those who attended college but took no science courses in either high school or college were as poorly informed on these four "touchstones" as those who never got beyond grade school.

The fact that exposure to science courses makes a difference in recalling science information seems incontrovertible, on the basis of these statistics. With mounting emphasis on science in high schools and colleges, the outlook would appear to be hopeful for science popularization in the future. Recall of news items about both science and medicine was greater, at every educational level, for those who had studied science.

Now let us turn to the individual results for each "touchstone." As for Salk vaccine, only 4 percent said they had never heard of it. The scope of this awareness of the existence of a vaccine for infantile paralysis was due in part to the tremendous amount of space and of time on the air that had been given to the dramatic and suspenseful story of Salk's research and of the large-scale testing of the vaccine. Few, if any, medical stories in recent years have aroused and sustained such public interest. Forty percent could recall at least some specific nontechnical details, and another 48 percent knew of the vaccine's existence, of its successful testing, or of its availability.

As for fluoridation of drinking water, 40 percent said that it prevented tooth decay, while another 11 percent gave such vague replies as, "it helps teeth." Twelve percent confused fluoridation with chlorination and 26 percent said they had never heard of fluorides. Thus, although dozens of American cities had held referendums on this topic during the past decade, only a bare majority (51 percent) of a national sample possessed valid information on which to base opinions. On the other hand, only 4 percent indicated opposition to fluoridation programs, and few of these expressed wild and emotional opinions such as had figured in some antifluoridation fights.

In 1957, one-third of the sample (33 percent) had never heard of radioactivity, although it had been discussed during the presidential campaign of the previous year. Twenty-five percent gave vague statements such as "it's dangerous," "it kills," or "it's like dust or fog from the bomb." A quarter (28 percent) made at least specific nontechnical replies, and 7 percent of these provided more or less technical information about fallout. Approximately a tenth (11 percent) reported having heard reports without having any idea what they were about. Apparently even the heat of debate in a presidential campaign cannot sear scientific information deeply into the minds of large segments of the population.

Either through extreme good luck or through intuition, the science writers included a question about "launching a space satellite, sometimes called a man-made moon," in the 1957 survey. With the successful launching of the first Soviet satellite some six months later, these figures became of special interest, and the Rockefeller Foundation provided additional funds for a postsatellite survey. Thus, it is possible to make a "before" and "after" comparison.

Table 2. Response to survey questions about satellite launchings, before and after the launching of sputnik I. Number in sample for 1957, 1919; for 1958, 1547.

Response	1957 (%)	1958 (%)
Had heard something and knew purpose	21	64
Had heard something but did not know purpose	14	23
Supplied misinformation	11	4
Had heard nothing	54	8
Not ascertained	Less than 0.50	1

The dramatic thing here is that within a matter of months, possibly within weeks, almost half of the United States public became aware of satellites. The space age was launched in the minds of men as well as in the skies. Details of the two satellite surveys show the breakdown given in Table 2.

Personal Bias

Analysis of the results obtained from a probing question—"From what you've heard, what is the purpose of launching these satellites?"—in the postsatellite survey illustrates how various segments of the public take the same information and transform it to fit their own frames of reference. Almost two-thirds of the 1547 individuals in the 1958 sample were aware of the general purposes of satellites, but when they were asked the probing question, their answers showed that they thought of them in terms of their own backgrounds or, as Walter Lippmann called them years ago, "stereotypes"—the pictures in their minds. This breakdown is given in Table 3.

Science communicators thus face this further barrier: Even if the information is presented accurately and without bias, the "consumers" of a story, broadcast, or television program still may convert and transform it to fit their prejudices and biases.

Table 3. Response to a question on the purpose of satellite launchings included in a survey made after the launching of sputnik I. Number in sample, 1547.

Response	(%)
For scientific information	27
Competition with the Russians	20
Future possibilities, such as space travel	17

That attitudes toward science do not exist in a vacuum also seems to be demonstrated by the marked decline in 1958 of mention of a "higher standard of living" as a major reason for a favorable evaluation of science. In the reasonably prosperous spring of 1957, 45 percent of all those questioned cited better living standards as a good effect of scientific activity. In the somewhat economically depressed spring of 1958, this percentage fell to 30 percent. Probably economic conditions were primarily responsible for this new skepticism about the scientific basis of living standards. If this is a correct hypothesis, then scientists and those concerned with science should realize that the public's recent high regard for and faith in science could still bend under harsh economic and political winds.

Coverage and Presentation

Regardless of whether or not the general public realizes how it twists science news to its own uses, it does have some uneasy doubts about the accuracy and methods of the four common media of communication in their presentation of science news.

Each respondent who mentioned a science news item presented in any of these media during the 1957 survey was questioned further about his opinions on the manner in which it was presented. Each was asked whether he thought the item was complete, easy to understand, interesting, and accurate. This technique restricted the gathering of opinions to those who actually used each medium.

Television, youngest of the media but the only one to combine both visual and oral presentation, was cited most often as being "very complete," "very easy to understand," "very interesting," and "very accurate." Seventy-one percent (the highest rating on this question) found television presentations "very interesting." Forty-three percent ranked television as "very complete."

When all the favorable votes—those for "very" plus those for "rather" for each medium—were combined, the votes for magazines moved up to those for television in the categories of ease of understanding, interest, and accuracy and moved slightly ahead in that of completeness.

Newspaper readers had some misgivings about the completeness and comprehensibility of newspaper coverage, and members of the radio audience had doubts about the completeness of radio coverage. Approximately one quarter of newspaper readers and radio audiences felt that these media gave too few details in reporting science news. Statistics for those who ranked these media "rather incomplete" or "very incomplete" are as follows: for radio, 26 percent; for newspapers, 23 percent. A fifth (20 percent) of newspaper readers found science items either "rather difficult" or "very difficult."

Some scientists have voiced this same complaint about the completeness of newspaper reporting of science news. Possibly the general public was echoing what it had heard said by the scientists. In any case, mass communicators may well search their souls and review their techniques.

In evaluating the media for accuracy, the public also expressed some doubts. This showed up among those who thought the medium was "rather accurate" rather than among those who actually believed the medium was inaccurate. Percentages for this "rather accurate" (instead of "very accurate") rating ranged from 48 percent for newspapers, which received a rating of 27 percent under "very accurate," to 33 percent for television, which got a rating of 51 percent under "very accurate."

Is the difficulty here primarily one of complexity of material, or do science reporters need to improve their techniques and develop new ones to present these complicated facts?

The 1957 survey showed fairly conclusively that the way a reporter writes his science story does make a difference in the amount of interest it will generate in the reading public. To obtain information on this point, half the respondents were asked whether they would be "very much interested" in reading about a set of fairly abstract science topics and the other half were requested to rank concrete ideas or headline-type wordings that dramatized comparable material.

While the results were not wholly consistent in the nine comparisons made, generally they did show that those presentations considered more alluring by the science writers did get more attention from readers. This was true for individuals of all educational levels, from college men and women right down to those who never got beyond grade school. The *average increase* in rating for the dramatized or headline types of presentation was 7 percent.

Thus, the way in which science news is packaged helps to determine its impact on the public. Scientists should consider this finding before they object too vigorously to the way writers have handled news the scientists wanted to be sure the public would receive.

Implications for the Space Age

These findings have added pertinence for the space age because a survey of managing editors on United States newspapers showed that three-quarters of the nation's dailies increased the space allocated to science stories by at least 50 percent during the first year after the launching of sputnik I.

The National Association of Science Writers and New York University sent questionnaires to every fourth managing editor in the country. Approximately 60 percent of those queried sent back answers. When editors were asked to compare the amount of space currently allocated to science news in their papers with that devoted to science a year or two before the launching of the first satellite, almost two editors out of every five (38.3 percent) reported that their publications were now allocating twice as much space, or even more, to science. A slightly smaller percentage (36.7 percent) said their papers were using between 50 and 100 percent more space for science news than they did a year or two ago. Not a single editor reported that his paper had curtailed the amount of space given to science news. Only 11, or less than one in 20, estimated that the space allocation had not increased.

Four-fifths of the editors said their papers had "special interest" in "satellites and outer space." More than half listed "medicine and public health" as well as "atomic energy."

With more and more funds for science coming from the public, either as grants from tax money or through public subscriptions, scientists have an enlarging stake in helping science reporters tell their stories so that the basic facts get through and are remembered. The public is curious, and if information is dramatized so that it can be comprehended and assimilated, then readers, listeners, and viewers will acquire that understanding of science that is becoming more and more important in a democracy.

Explanation and Prediction in Economics

The basic statements of economics may serve to explain the past but not to predict the future.

Andreas G. Papandreou

Economics, in contrast to the other social sciences (certain branches of psychology exempted), consists of fairly elaborate deductive systems and relies, therefore, on formal logical-mathematical methods to a much greater extent than they do. Typically, empirical evidence is brought to bear on its constituent statements in a fairly complex manner which is akin to procedures in the natural sciences. This notwithstanding, economics shares with the other social sciences certain fundamental characteristics which set it apart from the natural sciences. These differentiating characteristics become evident primarily at the level of interpretation of the formal systems employed by the economist; in other words, they have to do with the manner in which, and the extent to which, the constituent statements of economics gain empirical content.

A deductive system consists of a calculus side by side with an interpretation of its terms. A calculus is a collection of symbols along with a set of rules for their manipulation. Questions of meaning and therefore of truth or falsity do not arise in the context of a calculus. The calculus is exclusively a device for transforming sequences of symbols according to the rules laid down by the manipulator. When the calculus is coupled with an interpretation of its terms (that is, with a set of rules establishing the meaning of its terms) it becomes a deductive system. In certain deductive systems the rules of interpretation are sufficient to establish the truth or falsity of their constituent statements. Such deductive systems are called *pure,* while their statements are called *L-determinate.*

Logic and mathematics are pure deductive systems. Consider, for instance, the statement "if the cat is black then the cat is black." The interpretation given to the logical connective "if . . . then" makes the statement true independently of any reference to empirical data. On the other hand, the statement "the cat is black" cannot be assigned a truth value (that is, called true or false) on the basis of the rules of interpretation in the relevant deductive system. Such a statement, then, is *non-L-determinate.* The assignment of a truth value to non-L-determinate statements requires a rule of disposition by reference to empirical data. Non-L-determinate statements for which a rule of disposition by reference to empirical data has been formulated are called "factual" statements, and the deductive systems in which they appear are called *applied.*

It should be clear, of course, that economics does not consist of pure deductive systems (*1*). If it did, it would be a branch of logic or mathematics. This does not necessarily imply, however, that it consists of applied deductive systems. Insofar as its deductive systems contain non-L-determinate statements, it is incumbent upon the economist to evolve disposition rules for them by reference to empirical data, thus spelling out the conditions under which they will be accepted or rejected on the basis of evidence. To be sure, it is not necessary to develop a disposition rule for *every* non-L-determinate statement in a deductive system. It is sufficient that the economist establish a rule of disposition for at least *some* of the statements. A deductive system is given meaning as whole, not piece by piece.

A Sample Economic Model

In order to develop some appreciation for the problems that confront the economist in his attempt to formulate empirical hypotheses, it is worth our while to consider a rather simple "model" of national income determination. The "model" is an oversimplified version of fairly standard, textbook-type constructions dealing with the determination of national income and other related aggregates. We begin by writing down a system of equations (postponing for the time being some basic questions concerning the deductive system in which these equations appear).

$$\begin{aligned} &1.\ Y = C + I + G \\ &2.\ Z = Y - T \\ &3.\ C = a + bZ \\ &4.\ I = u + vY \\ &5.\ T = rY \end{aligned} \qquad (1)$$

The system consists of five equations in six variables (Y, C, I, G, Z, and T) and five structural parameters—undetermined constants (a, b, u, v, and r) which fix the form of equations 3, 4, and 5. Y stands for the dollar value of national income, C for aggregate expenditures of households on consumption, I for aggregate expenditures of business firms on capital expansion (investment), G for aggregate expenditures on the part of government on goods and services, T for aggregate receipts from an income tax, and Z for disposable income (that is, the difference between national income and income tax receipts). Equation 1 provides a definition of national income; equation 2 defines disposable income; equation 3 incorporates a hypothesis concerning the consumption behavior of households; equation 4 incorporates a hypothesis concerning the investment behavior of business firms; and, finally, equation 5 gives expression to the income tax law.

The fact that we have six variables and only five equations is not accidental. The presence of "extra" variables in the system is part of the economist's strategy, as is argued subsequently in this section. Assuming that the values of the structural parameters (a, b, u, v, and r) are appropriately restricted, so that the system satisfies the standard criteria of independence and consistency, we may solve for the values of five of the six variables in terms of the values of one. The variables whose values are deter-

The author is chairman of the department of economics, University of California, Berkeley.

mined within the system are called *endogenous*. The variable to which arbitrary values may be assigned is called *exogenous*. The selection of the variable destined to play the role of exogenous variable is not completely arbitrary. The characterization of a variable as exogenous implies that its value is set independently of the values assumed by the endogenous variables. In our simplified "model," G qualifies for selection as the exogenous variable.

The solution of the system of equations takes the form of five reduced-form equations which give the systemic or solution values of the endogenous variables in terms of the values assigned to the exogenous variable. Thus, for instance,

$$Y = \frac{a+u}{1-[b(1-r)+v]} + G\frac{1}{1-[b(1-r)+v]} \qquad (2)$$

is the reduced form equation for endogenous variable Y, expressing the solution value of Y in terms of G.

Typically the economist does not provide us with quantitative information concerning the values of structural parameters. He is satisfied in merely characterizing their scope or range of variation. Usually, but not universally, these restrictions on the permissible values of the parameters are derived from elaborate "models" concerning the behavior of economic agents (such as households, firms, and government) or from "models" of the functioning of the market mechanism. *Econometricians,* in contrast to general economists, are concerned with providing statistical estimates of the values of the structural parameters. Our discussion here is restricted to the activities of the general economist. The question arises then: Of what use are these constructions if they do not provide us with quantitative information? The answer to this question is the key to much of what economists do.

Let us differentiate expression 2 with respect to G. The result is

$$\frac{dY}{dG} = \frac{1}{1-[b(1-r)+v]} \qquad (3)$$

This expression, known as the income *multiplier* of government expenditures (for the "model" in question), gives us the instantaneous rate of change of the solution value of Y with respect to G. The general economist is primarily concerned with its *sign*. In this instance, its sign depends on the sign of the denominator, $1-[b(1-r)+v]$. We know that the denominator cannot be equal to zero, for otherwise the system of equations has no solution. If $b(1-r)+v>1$, then the multiplier is negative; if $b(1-r)+v<1$, then the multiplier is positive. As was indicated above, the economist may be able to argue, on general grounds, that $b(1-r)+v<1$, and therefore the multiplier is positive. As a matter of fact, considerations of the stability of equilibrium (this concept is discussed in the section on augmented models) force the economist to assert that $b(1-r)+v<1$. They "force" him in the sense that the whole procedure—including the derivation of the multiplier—would become meaningless unless stability of the system were assumed. We may conclude, therefore, that an increase (decrease) in government expenditures will lead to an increase (decrease) in national income. This may or may not be an interesting conclusion depending on how seriously one takes the "model" in question.

This type of deductive inference which leads to a statement concerning the direction of change of an endogenous variable with respect to the direction of change of an exogenous variable is typical of the branch of economics which is identified as *qualitative economics*. The discussion in this paper is restricted to issues arising in the practice of qualitative economics.

Basic Statements of the Model

The five equations of our "model" are presumably embedded in a deductive system. Equations as such are not statements; they are what logicians call *open sentences,* true for some substitutions for the variables, false for others. For instance, the equation $y=2x$ is true for the substitutions $x=1, y=2$; it is false for the substitutions $x=1, y=1$. In order to convert an open sentence into a statement we must *close* the sentence by appropriate quantification. For instance, we could say "there exists a pair of numbers (x, y) such that $y=2x$." This is a statement, and furthermore it happens to be true. The expression "there exists . . ." is called by logicians the *existential quantifier*. Consider now the equation $x+y=y+x$. In this instance, the open sentence may be closed by means of a *universal quantifier*—for we can say, "for all pairs of numbers (x, y), $x+y=y+x$." This, again, is a statement.

In order to understand how the equations of our simple system are to be quantified, we must introduce one more technical concept, namely the concept of *relation*. Consider again the equation $y=2x$. For some purposes we wish to characterize in a summary way the set or collection of all the points (x, y) which satisfy this equation. This collection is a relation. Symbolically,

$$R = [(x, y) \mid y = 2x] \qquad (4)$$

In words, R is the collection of all the pairs of the form (x, y) which satisfy the equation $y=2x$. (R corresponds to the graph of a straight line through the origin with slope equal to 2.) Equations, then, characterize relations.

We are in a position now to write down the relations characterized by our five-equation system.

$$\begin{aligned}
F_1 &= [(Y, I, C, Z, T, G) \mid Y = C + I + G] \\
F_2 &= [(Y, I, C, Z, T, G) \mid Z = Y - T] \\
F_3 &= [(Y, I, C, Z, T, G) \mid C = a + bZ] \\
F_4 &= [(Y, I, C, Z, T, G) \mid I = u + vY] \\
F_5 &= [(Y, I, C, Z, T, G) \mid T = rY] \qquad (5)
\end{aligned}$$

In order to simplify the notation, let us replace (Y, I, C, Z, T, G) by x. It should be clear that if we argue that x satisfies some equation in our system, it must be an element of or belong to the relation characterized by that equation. Thus our five equations may be replaced by five open sentences of the following form:

1. $x \varepsilon F_1$
2. $x \varepsilon F_2$
3. $x \varepsilon F_3$
4. $x \varepsilon F_4$
5. $x \varepsilon F_5$ (6)

where ε means "is an element of" or "belongs to." These are open sentences because for some values of x the sentences become true, while for others they become false. At this point we require appropriate quantification—somehow these sentences must be closed in order to make them into statements (which are either true of false).

The economist would like to argue that, if values of the variables (Y, I, C, Z, T, and G), or simply x, are observed according to some *observation rule* E (which may be very elaborate), the observed x will satisfy the relations F_i, $(i=1, 2, \ldots, 5)$. If we denote the observation acts by α, and if we write Λ for the universal quantifier and $\rightarrow$ for the connective "if . . . then," the state-

ments of our deductive system take the form

$$\underset{\alpha\ x}{\Lambda\Lambda}[(\alpha, x)\varepsilon E \rightarrow x\varepsilon F_i], \quad i = 1, 2, \ldots, 5 \quad (7)$$

Expression 7 is to be read as follows: For all observation acts α on x, *if* the observation acts on x are carried out according to rule E [that is, the pairs (α, x) are elements of E], *then* these observed values will be elements of the relations $F_1, F_2, \ldots, F_5$ (*2*).

We have succeeded in writing the basic statements (or axioms) of our "model." At the same time we have come face to face with a difficult and fundamental problem in the construction of theory in economics, and more generally, in the social sciences. Our statements are universal in character, and to the extent that disposition rules by reference to empirical data have been formulated, they have empirical content. (We shall come back to this question in the next section.)

It is well-known, of course, that in the case of universal statements a single contradictory instance suffices to falsify them. Is the economist ready to take the consequences, if a single contradictory instance is discovered? That is to say, is he ready to scrap his "model" if such an instance is unearthed? The answer is no. For instance, suppose that we test this "model" in a feudal or a tribal economy, and that we demonstrate the falsity of its constituent statements in that context. The author of the "model" would argue immediately that the "model" was never meant for such an economy. If in turn we ask that the economist specify the economy for which the "model" was meant, we will get a vague answer at best. The economist might say, for instance, that the "model" was meant for the American economy in the 1950's. Such a statement, however, would carry the consequence that the "model" was never meant as a "theory," but rather that it was meant as a description of the economic behavior in an individual instance—namely the American economy in the 1950's. If we wish to claim that our "model" is a "theory," we would either have to accept the statements in expression 7 without qualification, without specification of the context in which the expression is supposed to be applied, or we would have to provide a specification of the context of its applicability in *general* (nonindividual) terms. The term *social space* will take the place of the awkward term *context* in what follows.

In attempting to characterize the social space for which the "theory" or "model" is supposed to be asserted, we must guard against the error of characterizing it in terms of the properties of the relations which make up our deductive system. Were we to assert, for instance, that the "model" is supposed to hold in the social space in which consumer behavior is described by equation 3 of expression 1, and so forth, we would turn our deductive system into a pure system, thus escaping forever an encounter with empirical data. The social space, therefore, must be characterized here in general terms and independently of the information contained in our basic relations. This is a hard task which has never been fully carried out by economists. Indeed it is difficult to say whether any attempts to characterize social space in an appropriate manner will ever be successful. The whole matter needs careful thinking through before predictions on this score can be made.

Empirical Content

We have discovered that the economist is not prepared to commit himself to statements of the form

$$\underset{\alpha\ x}{\Lambda\Lambda}[(\alpha, x)\varepsilon E \rightarrow x\varepsilon F_i]$$

without inserting a qualification concerning the relevant social space, while at the same time he is not prepared to characterize it. This implies that the basic statements of his deductive system contain uninterpreted terms. The implications of this state of affairs can best be brought out by introducing social space formally into our deductive system.

Let us denote by k observation acts intended to identify social space, and by K^r the class of all observation acts whose outcome is the identification of the r^{th} social space (*3*). The observation acts k on social space must be carried out in conjunction with but independently of the observation acts α on x. This notion may be expressed compactly by αPk. Thus we may now replace expression 7 by

$$\underset{k\ \alpha\ x}{\Lambda\Lambda\Lambda}\{(k\varepsilon K^r \text{ and } \alpha Pk) \rightarrow [(\alpha, x)\varepsilon E \rightarrow x\varepsilon F_i]\} \quad (8)$$

This expression reads as follows: For all observation acts k on social space, and all observation acts α on x, and for all x, *if* k is an element of K^r (that is to say, if the observation acts on social space identify the r^{th} social space), and if the observation acts k on social space are carried out in conjunction with but independently of the observation acts α on x, *then* if the observation acts α on x are carried out according to rule E, x belongs to relation F_i.

The fundamental difference between expressions 7 and 8 is this: In expression 7 the flat assertion is made that the observed values of x satisfy the relations F_i. In expression 8 a conditional assertion is made—namely, it is asserted that the observed values of x satisfy the relations F_i, *if* the observations on x are carried out in the r^{th} social space. If economists were in a position to provide an interpretation for all the terms of the antecedent (the "if" part) of the major implication in expression 8, the difficulties would disappear, and it could be claimed that the construction of theory in economics would not present any *sui generis* problems. As a matter of fact, neither K^r nor P can be given appropriate characterization at this juncture in any of the well-known economic theoretical constructs; thus the antecedent of the major implication in expression 8 remains uninterpreted.

The implications of this state of affairs are as follows: Suppose that in some particular instance the observed values of x satisfy F_i. Then, the consequent (the "then" part) of the major implication in expression 8 is confirmed. However, as is shown in Table 1, if the consequent of the implication is true, the whole statement is true, independently of the truth value of the antecedent. Thus, in this instance, the statement as a whole is *confirmed*. Suppose, however, that the consequent of the major implication in expression 8 is *not* confirmed, that the observed values of x do *not* satisfy relation F_i. In this eventuality the truth of the statement as a whole would depend on the truth value of the antecedent. (If the antecedent is false, the statement is true, otherwise false.) Since, however, the terms of the antecedent have not been interpreted, it is impossible to decide whether or not the statement as a whole is true. The consequence seems to be that statements of form 8 are *only* capable of being confirmed by reference to empirical data, as long as terms in the antecedent of the major implication in the expression remain uninterpreted.

Deductive systems whose constituent statements are capable of confirmation but not of rejection will be called *models*. It follows from the argument thus far that economists construct models rather than theories. A theory may be given form 7 or 8. If it is given form

8, K^r and P should be provided with an interpretation. If they are not, then we are dealing with a model rather than with a theory. Interestingly enough, economic models provide explanations of economic behavior in those instances in which they are confirmed, but they cannot be used as predictive devices because the conditions of their applicability cannot be spelled out beforehand. Thus we arrive at the rather odd conclusion that economic models are *strictly explanatory* devices (*4*). Statements in models gain empirical content—but in the restricted sense that only rules for their *acceptance* by reference to empirical data can be formulated.

The fact that economic models are strictly explanatory devices does not mean, of course, that economists are unwilling to make predictions. Indeed, often enough they are called upon to do exactly that. What it does mean is that predictions based on models are necessarily dependent upon the state of mind of the economist about to make a prediction. If I am called upon to make a prediction concerning the effect of some tax measure on income or employment over the next 3 years, say, I will have to choose that model (among many alternative available models) in terms of which the prediction is to be made, which in my opinion stands the best chance of being confirmed by the observations on x over the next 3 years.

We may formalize this process of choosing a model by arguing that the economist about to make a choice of a model is guided by a *subjective ordering* of models with respect to the likelihood of their confirmation by reference to data relating to a given historical individual, such as, say, the U.S. economy for the period 1960–1963. Success or failure on previous occasions will no doubt affect the subjective ordering but will turn out to be a very poor guide if the underlying economic structure is subject to sudden temporal or significant spatial changes. We cannot escape the fact that the ordering of models with respect to the likelihood of confirmation is a highly subjective matter. Forecasting on the basis of models is and will remain an *art*.

Augmented Models

In qualitative economics the statements which are subjected to confrontation with data have to do with the direction of change of endogenous variables in response to changes in exogenous variables. In our sample economic model we arrived at the conclusion that an increase in government expenditures, G, would lead to an increase in national income, Y. Were we to subject this statement to a test, however, we would find ourselves forced to introduce significant additional specifications of our model. It is clear, for instance, that our theorem concerning the sign dY/dG relates to the solution values of Y, to values of Y which satisfy the postulated system of equations. This immediately suggests that the evidence brought to bear on our model should consist of pairs of values (G, Y) taken from observed sequences over time which have the property of being stationary or constant over time. Since time has not been introduced explicitly into our model, the concept of stationariness or steady state cannot be fitted in, unless we stand ready to revise our model by the introduction of *dynamic* considerations. This can be done by dating our variables and introducing appropriate time-lags (*5*).

Table 1. The semantic or meaning rule for $\rightarrow$; P and q are any two statements.

P	q	$P \rightarrow q$
True	True	True
True	False	False
False	True	True
False	False	True

As soon as this dynamization has taken place, the solution values of our variables (in the original, nondynamic model) will turn out to be the steady-state values of the dated variables (in the revised, dynamic version); and the theorem concerning the sign of dY/dG will be restricted to the steady state values of the dated variables. Naturally, a theorem such as this can be derived within the dynamic model only if the dynamic model possesses the property of stability (*6*). This implies that appropriate restrictions must be imposed on the structural parameters of the dynamic model (and, by implication, on the nondynamic earlier version) which guarantee stability. Furthermore, our observation rule E must be revised in such a fashion that only steady-state values of our variables are taken into account.

It is obvious that in the process of testing a simple qualitative statement, we are forced to expand and revise our model in order to make such a test possible. Nor is the revision considered thus far sufficient. Probabilistic considerations must also be introduced. We cannot reasonably expect that the values of our variables will exhibit *exact* constancy over time; rather we can only hope that they may exhibit approximate constancy. Also, when we talk about a change in G or a change in Y, we presumably wish to restrict the argument to "significant" changes. All this requires the introduction of probabilistic statements.

What we end up with then is not the original, *basic* model, but rather an *augmented* model. It should be fairly obvious that a basic model can be augmented in a very large number of ways. Indeed, to every basic model there corresponds a class of augmented models. If the fundamental hypotheses of the economist are contained in the basic model, whereas the augmented versions are viewed as constructions incidental to testing the basic model, it would follow that the economist should not be willing to abandon his basic model unless *all* possible augmented versions have failed to be confirmed. It is clear that under these circumstances the basic model would enjoy a high degree of insulation from the impact of empirical evidence. Indeed it is often the case that the augmentation of the basic model is carried out *after* the data to be explained have been examined and in a manner which insures that the basic model will be confirmed. This is typical, of course, in the work of economic historians. It should be mentioned, perhaps, that econometricians always work with fully developed (augmented) models—and that their models, therefore, do *not* enjoy the insulation from the impact of data which is characteristic of the basic models of the general economist.

Conclusions

In this paper I have attempted to bring out the character and extent of the empirical content of statements in economics. The basic result can be summarized as follows: Economists construct models, not theories. Their models may be confirmed by reference to empirical data, but they cannot be refuted. Therefore, they are strictly explanatory in character. Futhermore, since the models are typically proposed in a basic form, and since to each model corresponds a class of augmented models (whose form is such as to enable the economist to carry out relevant tests), the economist has a great deal of flexibility in choosing the particular final form of the model to

be subjected to test. This state of things need not be considered as unsatisfactory, if a liberal interpretation is given to the notion of empirical content. Furthermore, no change in this practice may be expected unless we succeed in characterizing social space and in giving it an appropriate place in the construction of economic theory. Whether this is feasible or not cannot be settled until more effort in this direction has been exerted.

Notes

1. This statement is restricted to what may be called *positive economics*. The branch of economics dealing with normative propositions, known as *welfare economics*, does consist of pure deductive systems.
2. Strictly speaking, the F_i's are not relations because they have not been completely specified. This problem will not occupy us here.
3. The r^{th} social space may be thought of as the r^{th} subset of all the possible states of the world. These are rather involved notions, but it would take us too far afield to attempt further elucidation in this article.
4. In the philosophical literature the distinction between explanation and prediction is of minor importance. An explanatory device is generally considered to be capable of prediction and vice versa. The claim made in this article that models are *strictly explanatory*—that is, incapable of use as predictive devices—stems from the assertion that there exists a class of non-L-determinate statements which may be confirmed, but may *not* be rejected, by reference to empirical evidence.
5. This procedure leads to the formulation of a system of difference equations. We could, of course, achieve the same objective by formulating a system of differential equations.
6. The notion of dynamic stability is far too complex for discussion in this article.

Selected Bibliography

R. B. Braithwaite, *Scientific Explanation* (Cambridge University Press, Cambridge, England, 1953).

P. W. Bridgman, *The Logic of Modern Physics* (Macmillan, New York, 1927).

R. Carnap, "Foundations of logic and mathematics," in *International Encyclopedia of Unified Science* (Univ. of Chicago Press, Chicago, Ill., combined ed., 1955), vol. 1, pt. 1, p. 143.

M. Friedman, *Essays in Positive Economics* (Univ. of Chicago Press, Chicago, Ill., 1953).

C. G. Hempel, "Fundamentals of concept formation in empirical science," *International Encyclopedia of Unified Science* (Univ. of Chicago Press, Chicago, Ill., 1952), vol. 2 No. 7.

W. C. Hood and T. C. Koopmans, Eds., *Studies in Economic Method* (Wiley, New York, 1953).

T. C. Koopmans, Ed., *Statistical Inference in Dynamic Economic Models* (Wiley, New York, 1950).

A. G. Papandreou, *Economics as a Science* (Lippincott, Chicago, Ill., 1958).

L. Robbins, *An Essay on the Nature and Significance of Economic Science* (Macmillan, London, 1932).

P. A. Samuelson, *Foundations of Economic Analysis* (Harvard Univ. Press, Cambridge, Mass., 1947).

H. Simon, *Models of Man* (Wiley, New York, 1957).

American Science between 1780 and 1830

The exploration and industrialization of the new nation led to advances in natural science and technology.

D. J. Struik

When, in 1783, the United States had emerged victoriously from the ordeals of the Revolutionary War, liberal-minded men and women on both sides of the ocean held high hopes that the new freedom would bring a flowering of the arts and sciences. Fair Columbia, whose Fathers were sages such as Franklin and Washington, had indeed many leaders who had given proof of their concern with the cultivation of knowledge for the betterment of man. The men around the already well-established American Philosophical Society in Philadelphia, soon the capital—Jefferson, Rush, Rittenhouse, and Bartram, not to speak of Franklin—and the men around the new American Academy of Arts and Sciences in Boston—Adams, Cutler, and Bowdoin—had, even during the war, continued to cultivate the sciences. In all the towns along the Atlantic coast were serious gentlemen of scientific inclination, often connected with the colleges in Cambridge, New Haven, New York, Philadelphia, and Williamsburg.

The author is on the staff of the mathematics department of Massachusetts Institute of Technology, Cambridge. This article is based on the author's address to AAAS-Section E (geology), in a symposium on the history of geology, at the AAAS meeting in Washington, D.C., 27 December 1958.

Growth from Colonialism

These great hopes were bound to be frustrated, at any rate during the early years of the republic. The primary task of any country emerging from colonialism is to catch up with the advanced part of the world, and the United States had many men only too willing to work for this goal. The main efforts had to be economic and political: improvements in transportation and in industry, as well as the raising of the political position of the country among the nations of the world. These tasks, once undertaken, were successfully carried out despite great handicaps: canals were dug, turnpikes were laid out, factories were built, mass production was inaugurated, steamboats were constructed. The Louisiana Purchase improved the political condition of the country in relation to the French, British, and Spanish empires beyond all expectations, giving the United States, moreover, an entrance into the profitable fur trade. The period which opened with the Lancaster turnpike near Philadelphia and the Middlesex Canal near Boston ended with the extension of the National Road far into the deep Middle West and with the ambitious project of the Erie Canal. Opening with the experiments of John Fitch and Oliver Evans in steam navigation (Fig. 1), it ended with the great successes of Robert Fulton's invention on eastern and midwestern rivers, and even (though these were only tentative) on the ocean. It opened with the feeble experiments of Orr, Cabot, and others in textile machinery and ended in the fulfillment of Samuel Slater and Francis Cabot Lowell's experimentation in the factory towns of New England, and even in the foundation of whole new cities, such as that show place, Lowell. It opened with a few merchant ships setting out from Salem, Boston, and other harbors to China and the northwest Pacific and ended with the American merchant marine all over the globe. This progress, begun rather slowly during the early federalist days, gained impetus with the expansion of the popular forces in the days of Jefferson, Madison and Monroe.

This was progress indeed, even though we must be careful in our use of this

word. There was an advancement in science and technique, carried out by a triumphant democracy. It helped many a man to establish a comfortable life and opened untold opportunities for native craftsmen and for immigrants from politically and economically depressed areas of Europe. However, we must not forget that at the same time Eli Whitney's invention of the cotton gin reestablished slavery in the South, that Slater and Lowell's introduction of the factory system created a badly exploited working class, and that the opening of the West spelled lasting doom for the Indians. It was progress for many, but not for all.

The spread of scientific knowledge in its stricter, academic sense at the beginning of this period was much slower than the increase in technology. In those federalist days science was, to a considerable extent, only a continuation of the old mercantilist science of classifying nature, together with some mathematical astronomy and surveying—the one in the spirit of Linnaeus, the other in that of Newton. The stress was on the utilitarian—on the improvement of man's health, of his crop, of his garden, and of his purse, and hence also on his understanding of God's benevolence. But even in those days there were good botanists—William Bartram, Humphrey Marshall, Benjamin Smith Barton in Philadelphia, Gotthilf Mühlenberg in Lancaster, the Michaux at Charleston, and Manasseh Cutler near Boston. Benjamin Waterhouse, in 1788, began to give a college course in botany at Brown and at Harvard; other courses followed, given by Barton in Philadelphia and Mitchill in New York. The American Philosophical Society published *Transactions,* the American Academy in Boston published *Memoirs,* and the versatile Samuel Latham Mitchill in New York began to publish, in 1797, his *Medical Repository,* which included papers in the new sciences of mineralogy, geology, and chemistry.

Chemistry received a great impetus when, in 1794, Joseph Priestley came from witch-hunting England and settled in Northumberland. Several textbooks were published, but on a modest scale; only one book appeared which, in ever-new editions, has become a classic in its kind, the *New Practical Navigator* of Nathaniel Bowditch (1802).

Events of great scientific importance did occur in the America of the last decades of the 18th century, but they took place outside of the republic. The British, masters in Canada after 1763, pursued the age-old search for the Northwest Passage with renewed vigor, driven by the ever-extending hunt for furs. In 1793 Alexander Mackenzie, fur trader and geographer, who in 1789 had followed the "Mackenzie" system of rivers to the Arctic, reached the Pacific Ocean by traveling west from Chippewayan and crossing the Rockies. The trail was new, but the goal was a territory already visited by Russians, Spaniards, and Englishmen; when Mackenzie reached the coast, James Cook's former lieutenant, George Vancouver, was making his excellent topographical surveys nearby. The Yankees had also come; Captain Robert Gray of Boston, on his ship the *Columbia,* had just found the mouth of the great legendary river, the Oregon, and baptized it with the patriotic name of his ship. The great international search for furs in the Northwest was now really on. Men well remembered on the Canadian side are Simon Frazer and David Thompson—the latter, one of the

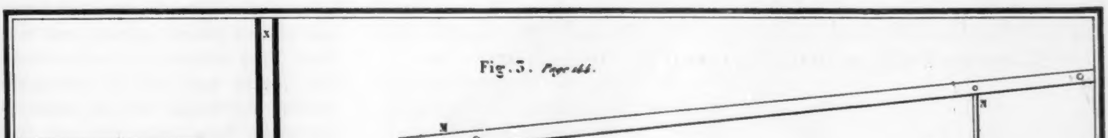


Fig. 1. Vertical section of the "drop-valve engine" (a steam engine of the "high-pressure" type) proposed by Oliver Evans in "The abortion of the Young Steam Engineer's Guide" of 1805. Evans, by 1802–03, had a steam engine installed in his flour mill in Delaware. Such engines were small; the engine shown has a boiler about 16 inches in diameter. Evans continued improving his engines until his death in 1819. [From "The abortion of the Young Steam Engineer's Guide," French translation, Paris, 1821]

greatest scientific geographers of America. The famous Lewis and Clark expedition, organized by the United States Government, was also directly related to the highly competitive enterprise of seeking the otter, the seal, and the beaver (*1*).

Great Explorations

A new period begins in 1801 with the administration of Thomas Jefferson. Science received new life in the wake of the popular movement. The President was himself a man of the widest interest in science and the author of the *Notes on Virginia,* and he became the symbol of the new democracy and the new awakening in science. His thoughts had often centered on the overland routes to the Pacific, with their problems of geography and the possibilities they offered for increase in knowledge of nature and for expansion of the fur trade, combined with their political importance in the face of the surrounding colonial empires of France, Spain, and England. The Louisiana purchase of 1803 found the President prepared. In 1804 William Clark and Merriweather Lewis set out for the Pacific under the auspices of the Federal Government; in two years they explored a large section of the West, along the Missouri through the Rockies to the mouth of the Columbia, and made at last the nature of the Rockies south of the Mackenzie route known to the world at large.

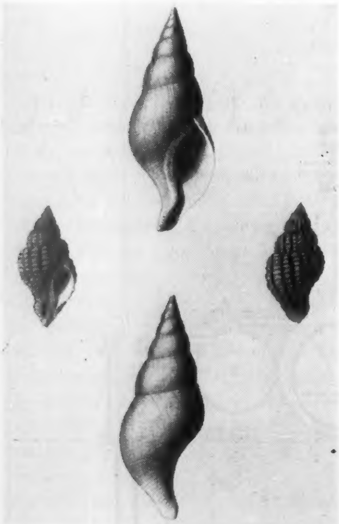


Fig. 2. Shells, drawn for Thomas Say's *American Conchology* [six issues (1830–1834); 60 plates] by Say's wife. The books were published in New Harmony, Ind. (Top and bottom) *Fusus corneus,* from the coast of New Jersey; (center) *F. cinereus,* from the same neighborhood.

At the same time Zebulon Montgomery Pike, commissioned by the Army, led two expeditions, one up the Mississippi to its supposed source in Leech Lake and one along the Platte and Arkansas rivers into the Rockies south of the Lewis and Clark region, where Pike's Peak carries the name of the young officer. Although, because of the embargo and the war with England, there were no more government expeditions until 1818, exploration of the West was undertaken by the newly chartered fur companies, among them Jacob Astor's company, which founded Astoria. Among the many results of the expeditions of these fur traders I mention only Robert Stuart's discovery of the South Pass (1812), which was to open the Oregon trail. In the meantime scouts also ventured to the southwest into Spanish territories and developed the Santa Fe trail, which became a veritable lifeline of trade after Mexico became an independent republic in 1821.

The Federal Government resumed the sponsorship of scientific expeditions when John Calhoun, in 1817, became Secretary of War in the Monroe administration. Stephen Long, between 1818 and 1819, was sent out twice, once up the Mississippi—in a steamboat—and once into the so-called "Great American Desert" as far as the Rockies, where Longs Peak bears his name. This time some scientifically trained men went with him; among them was Thomas Say of Philadelphia—botanist, entomologist, and conchologist (Fig. 2). In 1820 came the expedition led by Lewis Cass, governor of Michigan territory, which went by Lake Superior to the source of the Mississippi, now located at Cass Lake, beyond Leech (*2*). With Cass went Henry Schoolcraft as geologist and anthropologist and David Bates Douglass of West Point as topographer and botanist (Fig. 3). The reports of these expeditions were printed and widely read. The idea of government-sponsored research into the natural resources of the country now became accepted in wider circles, if only for direct utilitarian reasons (*3*).

It was not only traders, trappers, and government officials who ventured into the wilderness, and the wilderness, in those days, was not only the Great American Desert or the Rockies but well-nigh all territory more than, at most, a hundred miles away from the eastern cities.

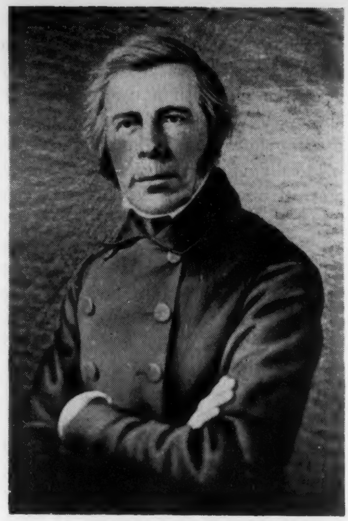


Fig. 3. Picture of David Bates Douglass (1790–1849), reproduced with kind permission from a portrait belonging to the family. Douglass, a Yale graduate, soldier, surveyor, teacher, botanist, architect, and canal builder, was a typical scientist-engineer of his time. He participated in the Cass expedition of 1820.

There were also privately sponsored scientific expeditions, and naturalists even entered alone into the forests and prairies to find plants, animals, and minerals. They followed an ancient tradition, set by such men as Hernandez, Catesby and Kalm, and the Bartrams, but where these older men had been either sent or commissioned by a European principal, the initiative now became more and more American. The Michaux, *père et fils,* were still commissioned by the French Government, and it is also true that William Maclure, who paid many of the bills of wandering scientists, was a Scotsman who had made his money in London, but Maclure did his own exploring and during his long stay in the United States identified himself with the country. From 1812 until his death in 1840 he was president of the Academy of Natural Sciences at Philadelphia, of which he was a founder.

Among the naturalists who went out, often for many months, sometimes on expeditions with others, sometimes quite alone, we find many of the great figures of early American science: the two Michaux, Alexander Wilson, William Maclure, Thomas Say, Constantin Rafinesque, Thomas Nuttall, Edwin James, James Audubon, Charles Lesueur, Titian Peale, and Henry Schoolcraft. While all had the true naturalist's universal, scien-

tific love of nature, they had their fields of specialization; Wilson (Fig. 4), Say, Nuttall, and Audubon specialized in birds, Maclure and Schoolcraft in geology, Rafinesque and Nuttall in plants, Lesueur in fishes, and Say in shells, while Lesueur and Peale made lovely sketches and drawings. I cannot here give an account of all their travels, from Florida to Vermont, from the Alleghenies to the Rockies, nor can I enumerate the many publications which came from their pens, some of which—for example, Maclure's *Observations on the Geology of the U.S.* (1809, 1817), Say's *American Entomology* (1824–1827), or Wilson's *American Ornithology* (1808–1813)—are classics in their field. In these men, those who like to trace "parenthood" in various fields of science have a wealth of subjects: Maclure is the father of American geology; Wilson, of American ornithology; and Say, of American entomology; to these names can be added those of Caspar Wistar of the University of Pennsylvania, father of American surgery, and Lewis von Schweinitz, father of the study of Cryptogamia.

This, truly, was the heroic age of American nature study. These scientific explorers braved for months on end the hardships of the wilderness, of prairie, forest, river, and mountain, the danger of hostile Indians, and the exasperating nuisance of insects, to bring back whole collections of stones, plants, animals, and artifacts. They were all most remarkable men, headstrong, with marked peculiarities which might even make them the butt of popular witticisms on posy-seekers and bug-hunters. The beginning of Dickens' *Pickwick Papers* reflects this attitude; an American counterpart is Dr. Obed Battius in Fenimore Cooper's *Prairie*, said to be a take-off of Thomas Nuttall. Many were liberal in their political outlook and confessed, with Mitchill of New York, that they "supported the republican party because Mr. Jefferson was its leader, and supported Mr. Jefferson because he was a philosopher." This explains why several of them showed enthusiasm for Robert Owen's socialistic and Maclure's pedagogic experiment at New Harmony, Indiana, on the Wabash. In the winter of 1825–1826, Say, Lesueur, and the Dutch geologist Gerard Troost joined the "Boat load of Knowledge" which sailed down the Ohio from Pittsburgh and landed at New Harmony. Though the colony failed as an experiment in social reform, New Harmony was and remained for many years a rendezvous in the wilderness for many naturalists.

Academicians

These naturalists in the field were supported by a number of outstanding scientists in the colleges. The number of such colleges was increasing considerably, though the teaching of the natural sciences and of advanced mathematics was only slowly introduced, even at the leading schools. Chemistry had come to the United States with Priestley, who found men willing to listen to him—men such as James Woodhouse in Philadelphia, John Maclean at Princeton, and Mitchill in New York—even though they did not follow the master in his philogiston theory. At the same time, with Priestley, came Thomas Cooper, who would for many years stir the South with his freethinking and his passion for scientific education.

The first native chemist whose research received wide attention was Robert Hare of Philadelphia, whose studies of the composition of water led him to the invention of a new kind of blowpipe for generating high temperatures. However, it was Benjamin Silliman, who gave his first lectures as a professor at Yale in 1804, who became America's best known chemist, not only by virtue of his research and his popular lectures but

Fig. 4. The Carolina parrot (now probably extinct) by Alexander Wilson. Spoiled as we are by Audubon's paintings, our appreciation of Wilson's bird pictures is not always what it should be. This may have been a picture of a living bird, since Wilson had one with him on his wanderings from Big Bone Lick, in Kentucky, to New Orleans, in 1810 (*4*). The other birds are flycatchers.

also as the founder and editor of the *American Journal of Science,* which still exists. It soon became the central organ for all naturalists in the United States.

Silliman, like Mitchill, was also a mineralogist and a geologist. Scientists in this field were a novelty in the United States. Maclure, as I have mentioned, had published a first comprehensive monograph on the geology of the United States in 1809, the result of much traveling. Many monographs followed, including local surveys by Mitchill in New York, by Silliman in New Haven, and by the Danas in Boston, as well as Schoolcraft's descriptions of the lead mines near Dubuque (1818) and the copper deposits of Lake Superior (1821). The first comprehensive text on mineralogy and geology was written by Parker Cleaveland of Bowdoin College (1816, 1822), which was long a standard text. In the 'twenties began that systematic surveying (first, through private initiative) of whole states which led to the great geological surveys of the 'thirties. The first of these surveys was the Deni-

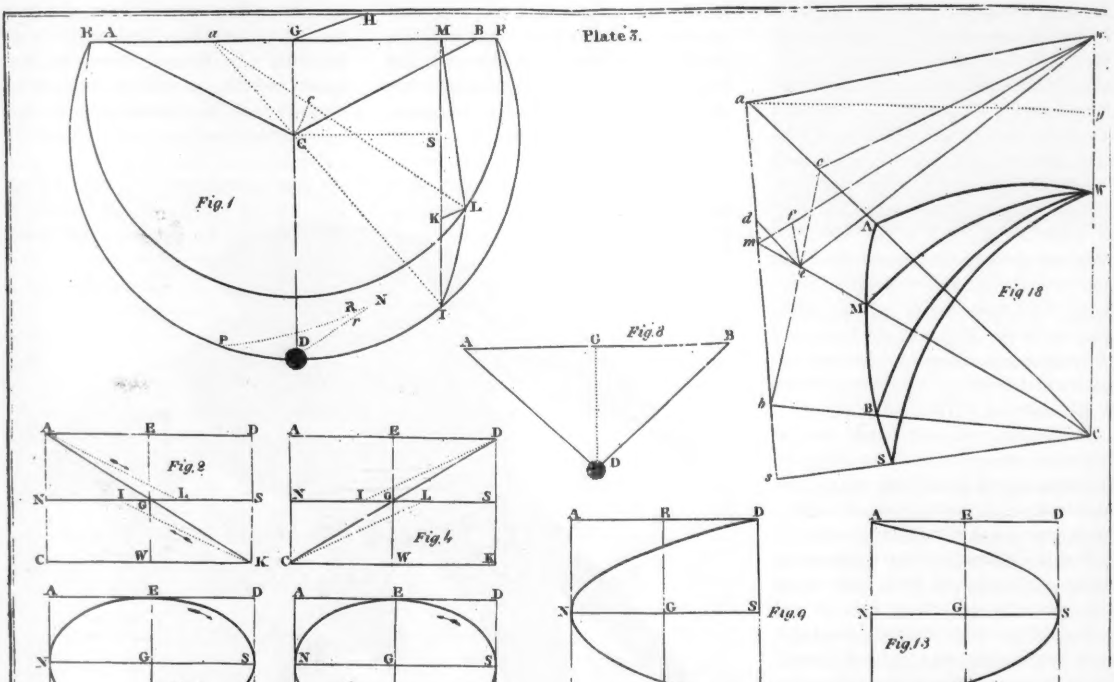


Fig. 5. Figures, known as Lissajous figures, developed by Nathaniel Bowditch (*5*) from his studies of the motion of a pendulum suspended from two points, through the application of Laplace's methods, as explained in the latter's *Mécanique céleste*. This is one of the earliest American contributions to theoretical mechanics.

son Olmsted survey of North Carolina in 1823 (made with state authorization); this was followed by the survey of Nova Scotia by Francis Alger and Charles Thomas Jackson in 1828.

Botany and zoology also advanced rapidly, in considerable part through study of the collections brought home by the surveying expeditions. The botanical collections of the Lewis and Clark expedition were analyzed by Frederick Pursh, a gardener of German stock who worked in several private botanical gardens in Philadelphia and New York; he published his results in London in his *American Flora* of 1813. The botanical collections of Long's expedition were analyzed by John Torrey of New York (1828); it was at this period that Torrey also worked on his description of all plants of the United States—an ambitious project started by Barton in 1803. Just as Cleaveland's work was followed by that of James Dwight Dana and Wilson's work by that of Audubon, so was Torrey's work followed by that of Asa Gray.

A word must be said about the remarkable scientific work done in some of the frontier towns. We think of New Harmony; of Gerard Troost in Nashville, after his farewell to New Harmony; of Daniel Drake in Cincinnati; and of Rafinesque at Transylvania University in Lexington, Kentucky. Among the most famous scientific frontier achievements was the series of experiments of William Beaumont on gastric juices, which began at the Mackinac Army post in the heart of the Indian country.

Exact Sciences

When we compare the gallant efforts of the naturalists, the successes of the chemists, botanists, and geologists, and the inventiveness of the canal and steamboat builders with the accomplishments of the mathematicians and physicists during this period, we are aware of an anticlimax. In the gradual emergence from a colonial economy, the sciences closest to the temper of the country enjoyed the greatest interest. Conditions in a republic of self-conscious citizens were different from those under a European monarchy where the more subtle arts could flourish under royal patronage. Even in electricity, where research was initiated with such success in Franklin's day, little advance was made before Joseph Henry, in the 'thirties, responded to the European discoveries of his day as Franklin had responded in his time. The pages of the *American Journal of Science,* though open to all the sciences and even to the arts, were singularly barren of papers on the exact sciences.

With Benjamin Thompson moping abroad as Count Rumford until his death in 1813, the only well-known representative of the physical and mathematical sciences of those days was Nathaniel Bowditch, pillar of the Boston Academy, the practical navigator whose translation of Laplace's *Mécanique céleste* began to appear in 1829 (Fig. 5). Among other mathematicians of this period was Robert Adrain, born in Ireland, who taught at several colleges in the East and edited the first purely mathematical journals in this country. Modernization of mathematical instruction came with John Farrar at Harvard, who translated several French texts. West Point, under Sylvanus Thayer, was headed in the same direction. Also from West Point came our first academically trained engineers. Rensselaer followed, founded in 1826, the oldest polytechnic institute in the country. The few medical schools were in many respects pioneers in the teaching of scientific subjects, not only in materia medica but also in chemistry and other natural sciences. It was Benjamin Waterhouse, of the Harvard Medical School, who in 1800 introduced cowpox vaccination into the United States. I have already mentioned other teachers at medical schools: Mitchill in New York, Wistar in Philadelphia.

The U.S. Coast Survey was founded in 1807, a foster child of Jefferson's. It was 1816 before the survey started work, under the leadership of Ferdinand Ru-

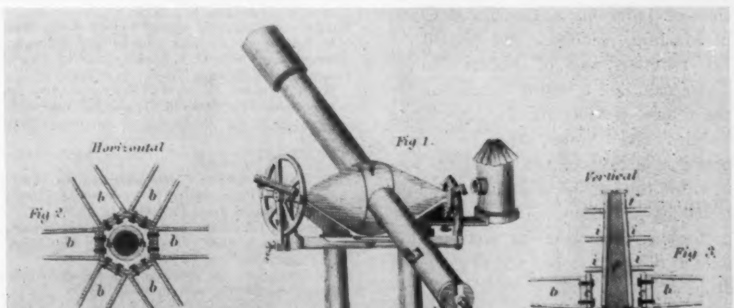


Fig. 6. Theodolite used by Ferdinand Hassler for his early work on the U.S. Coast Survey (*6*). It was constructed by the famous Edward Troughton of London. Its horizontal circle (*aa*) was 2 feet in diameter and was mounted by three compound microscopes of 1:14 enlargement. The telescope, of 2½-inch aperture, had four magnifying powers, the largest being 1:77.

dolph Hassler, a Swiss mathematician and surveyor, whose insistence on the highest possible accuracy of measurement set standards which have ever guided the survey, now called the U.S. Coast and Geodetic Survey (Fig. 6). After issuing some charts it discontinued its activities until 1832. The same lack of interest which characterized the Congress in matters of geodetic surveying can be seen in the frustration of attempts by Joel Barlow and others to found a national university and of John Quincy Adams to found a national observatory. His proposed "light houses in the sky" even became a butt for the wits of those days.

Perhaps I should not leave the subject on this note of anticlimax and should redirect attention to the pioneer naturalists and inventors of those days. We must first of all remember the period as the time of the great explorations and of the great start in industrialization—the time of Jefferson, of Lewis and Clark, of Maclure, Audubon, and Nuttall, of Eli Whitney, and of Robert Fulton. These men laid a lasting foundation for the future—notably for the astonishing 'thirties and 'forties, the Jacksonian period, the time of the geological surveys, the time of the railroads and other technological advances, the time of the professional scientists, as well as the time of the great causes and of the great debates.

References and Notes

1. Another important event was Alexander von Humboldt's expedition to the Orinoco and Andes regions, which ended in Mexico and in Humboldt's return to Europe in 1804, via Philadelphia and Washington, where he met many learned Americans, including President Jefferson.
2. David Thompson had done better in 1798, when he located the source of the Mississippi in Turtle Lake beyond Cass; see Thompson's narrative of his explorations in Western America, 1784–1812, J. B. Tyrrell, ed. (Toronto, Canada, 1916).
3. To this period also belongs the Russian expedition under Ferdinand Wrangel which, between 1820 and 1824, carefully studied the Siberian coast from the mouth of the Indigirka to Kolyuchin Bay and thus finally established that there is no land connection between Asia and America. Another Russian expedition under Fabian G. von Bellingshausen made geographical discoveries in the antarctic between 1819 and 1821. Here it met with Yankee sealers, among them Nathaniel Brown Palmer, the discoverer of Palmer (Graham) Land (1820).

4. *Am. Ornithol.* **1B**, 376–386 (1832).
5. *Mem. Am. Acad. Arts Sci.* **3**, 413–436 (1809).
6. *Trans. Am. Phil. Soc.* **2**, 232–420 (1825).

Bibliographical Notes

An extensive and classified bibliography for the colonial and early republican period can be found in W. J. Bell, Jr., *Early American Science* (Institute of Early American History and Culture, Williamsburg, Va., 1955).

Further orientation is offered by: B. Jaffe, *Men of Science in America* (Simon and Schuster, New York, 1944); D. S. Jordan, *Leading American Men of Science* (Holt, New York, 1910); W. J. Youmans, *Pioneers of Science in America* (Appleton, New York, 1896); and the biographical notes in the *Dictionary of American Biography.*

Additional literature:

J. B. Blake, *Benjamin Waterhouse and the Introduction of Vaccination: A Reappraisal* (Univ. of Pennsylvania Press, Philadelphia, 1957).
W. Couper, *Claudius Crozet. Soldier-scholar-educator-engineer (1789–1864)* (History Publishing Co., Charlottesville, Va., 1936).
B. De Voto, Ed., *The Journals of Lewis and Clark* (Houghton-Mifflin, Boston, Mass., 1953).
A. H. Dupree, *Science in the Federal Government* (Belknap, Cambridge, Mass., 1957).
S. W. Geiser, *Naturalists of the Frontier* (Southern Methodist Univ. Press, Dallas, Tex, 1948); see also *Southwest Review* **18**, 50 (1932).
J. E. Graustein, *Nuttall's Travels in the Old Northwest. An Unpublished 1810 Diary* (Chronica Botanica, Waltham, Mass., 1951).
B. Hindle, *The Pursuit of Science in Revolutionary America, 1735–1789* (Univ. of North Carolina Press, Chapel Hill, 1956).
W. H. Hobbs, "The discoveries of Antarctica within the American sector as revealed by maps and documents," *Trans. Am. Phil. Soc.* **31** (1939). [See L. M. Gould, *Isis* **32**, 214–218 (1940, 1947)].
S. D. McKelvey, *Botanical Explorations in the Trans-Mississippi West, 1790–1850* (Arnold Arboretum, Jamaica Plains, Mass., 1955).
A. P. Nasatir, Ed. *Before Lewis and Clark. Documents Illustrating the History of the Missouri, 1785–1804* (St. Louis Historical Documents Foundation, St. Louis, Mo., 1952), vols. 1 and 2.
D. C. Peattie, *Green Laurels. The Lives and Achievements of the Great Naturalists* (Simon and Schuster, New York, 1936).
D. P. Penhallow, "A review of Canadian botany from the first settlement of New France to the nineteenth century," *Proc. and Trans. Roy. Soc. Can.* (5) (1887), sect. IV, pp. 45–61; "A review of Canadian botany from 1800 to 1895," *ibid.* (3) (1897), sect. IV, pp. 3–6.
[Pharmacopeia] "Founding of the U.S. Pharmacopeia 1820." Dedication of a printing May 1, 1957. (New York, 1957.)
G. R. Prowell, "Frederick V. Melsheimer, a pioneer entomologist," *Proc. Colloq. Historical Soc. York County* **1**, 17 (1902–1903).
V. Stefansson, *Northwest to Fortune* (Sloane and Pearce, New York, 1958).
D. J. Struik, "Mathematicians at Ticonderoga," *Sci. Monthly* **82**, 236 (1956); *The Origin of American Science (New England)* (Cameron, New York, 1957) [new edition of *Yankee Science in the Making* (Little, Brown, Boston, Mass., 1908)].
J. B. Tyrrell, Ed. *David Thompson's Narrative of His Explorations in Western America, 1784–1812* (Champlain Soc., Toronto, 1916).
H. R. Wagner, *The Plains and Rockies. A Bibliography of Original Narrative of Travel and Adventure 1800–1865* (Grabhorn, San Francisco, Calif., 1937).
H. B. Weiss, "The pioneer century of American entomology" (New Brunswick, N.J., 1936) (mimeographed).

Geology, Geologists, and the AAAS

The inclusive association has an important role to play in a time of increasing specialization in science.

Kirtley F. Mather

Herman L. Fairchild, in his history of the American Association for the Advancement of Science (*1*) recorded the fact that on an old residence in Albany, New York, there was a bronze tablet bearing an inscription which told of the organization of the Association of American Geologists, the "parent body" (Fig. 1).

The decade of the 1830's was marked by an extraordinary burgeoning of interest in the newly developing science of geology in eastern North America. Water power was proving inadequate for the rapidly expanding industries. Exploitation of the coal of the Appalachian coal fields was moving ahead with increasing momentum. Mineral resources in great variety were insistently demanded to meet the needs for raw materials in the many new manufacturing plants. The survey of the four "Geological Districts of the State of New York" was getting well under way. The office of state geologist was inaugurated in Massachusetts and Virginia, and before the end of the decade, 17 states had made some sort of provision for geological surveys. Sound bases for geological thinking and for the interpretation of field observations had been established in Great Britain by William "Strata" Smith, Sir Roderick Murchison, Sir Charles Lyell, and others. Such knowledge was infiltrating what was then still the New World. Many professors of natural history or of natural philosophy in 20 or more institutions of higher learning, scattered from New England to Virginia, were concentrating their work upon the

small segment of their broad fields to which the designation *geology* could appropriately be applied.

The "Parent Body"

Ebenezer Emmons was professor of natural history at Williams College, but in addition he was responsible for the geological survey of the "second district" in New York state. This accounts for the fact that he had a "home" in Albany, where he later was professor of obstetrics in the Medical College. One can well imagine how eager was this scientist, trained in medicine and chemistry but essentially self-taught in geology, to secure advice from, and share ideas with, his colleagues in charge of the other three districts, or indeed with any of the small number of his contemporaries who were trying to unravel the complex structure of the rocks in New England and New York. Thus it was natural that from the bull sessions in his home should sprout "the first formal efforts . . . toward the organization of the Association of American Geologists." That association was actually organized in Philadelphia in 1840, with Edward Hitchcock as its chairman.

At its third meeting, in 1842, the Association of American Geologists was broadened in scope and became the Association of American Geologists and Naturalists. Hitchcock at the time was professor of chemistry and natural history at Amherst College. Not only he and Emmons but many others in the association were well aware of the dependence of geology upon the principles of physics and chemistry. Every stratigrapher in those days was a paleontologist, and the intimate relation between paleontology and biology was obvious. The association was therefore enlarged to include the workers in those fundamental and related fields, whose counsel the geologists very much needed.

This expansion in membership and member interests was a long step toward establishment of a national association broadly inclusive of all the sciences, and the model of such an association was at least sketchily known in America at that time. The British Association for the Advancement of Science had been founded in 1831 and was flourishing, along with the Royal Society of London,

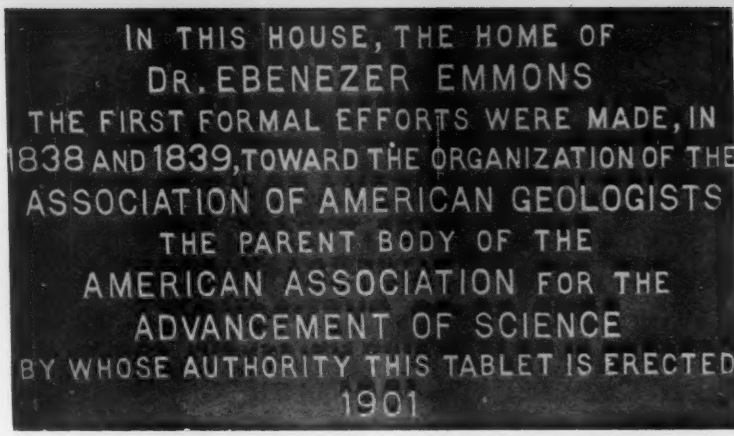


Fig. 1. Bronze tablet from the home of Ebenezer Emmons, Albany, N.Y. [Courtesy New York State Museum of Natural History]

in the 1840's. John C. Warren, a leading physician of Boston, had read a paper at the meeting of the British Association in 1837. After he returned to the United States a year later he actively campaigned for the organization of a similar society here. In his campaign he sought the support of the "American Philosophical Society Held at Philadelphia for Promoting Useful Knowledge," which had been founded by Benjamin Franklin in 1743.

The Philosophical Society, however, passed a resolution in 1839 declaring that in its opinion it was inexpedient for it to undertake the organization of the proposed association. It is quite likely that Warren also sought similar support from the American Academy of Arts and Sciences, chartered in 1780, of which he was a fellow, although I have found no record to prove that he did so. Both the Philosophical Society and the American Academy, then as now, were limited in membership to the few persons who were considered to be the intellectual elite of their time, whereas the proposed Association for the Advancement of Science, like its British model, was to be open to anyone who had any interest, no matter how peripheral, in improving the effectiveness of science in the promotion of human welfare.

Agassiz and the New Association

Louis Agassiz, famous for his studies of glaciers and glaciation, arrived in the United States from England in 1846, and in 1847 the Association of American Geologists and Naturalists decided to widen further its membership and become what was, to all intents and purposes, the American counterpart of the British Association. Agassiz undoubtedly had a great influence in effecting this change. When the transition was completed and the American Association for the Advancement of Science actually came into existence, in Philadelphia in 1848, he was chairman of the section of "Natural History, Geology, etc."

At that first meeting of the AAAS, the geologist William B. Rogers (Fig. 2) presided until the constitution and rules of order had been adopted. He then installed another geologist, William C. Redfield (Fig. 3) as the first president elected by the new organization. Thus Rogers' name is carried on the "Roll of AAAS Presidents" in the number one position—a tribute all the more justified by the fact that the program of the "general session" of that meeting indicates that he delivered an "annual address," thus setting the precedent for the "address of the retiring president" which has become an outstanding feature of subsequent annual meetings. It should be noted also that the list of 461 "original members" of the AAAS includes practically all of the fellows of the Philosophical Society and of the American Academy who were engaged in scientific pursuits, as well as many other leading scientists of the time. Evidently the fellows of those two learned societies had by this time developed the same attitude toward the broadly inclusive association as that long displayed by the fellows of the Royal Society toward the British Association.

The "Roll of AAAS Presidents," as carried in the current Program-Directory, lists 112 names, including that of Paul E. Klopsteg, who is serving as president in 1959. This happens to come

The author is professor of geology, emeritus, Harvard University, Cambridge, Massachusetts.
This article is based on a paper presented during the Washington meeting of the AAAS 27 Dec. 1958 before a joint session of Sections E and L of the AAAS and the Geological Society of America.

out even—one per year for the 112 years of the life of the association (1848–1959, inclusive). This is mere chance, however. There were no meetings and no presidents during the war years 1861–65. The 1852 meeting was postponed for a year because of "the prevalence of cholera along the approaches to Cleveland from the south," and there were two meetings and two presidents in 1902. Moreover, four presidents died in office and were succeeded by others in the same year.

Geologist Presidents

Six of the first nine presidents in this list were geologists. I include Agassiz in the six, even though his field is given as zoology, inasmuch as he was elected president in 1851, at a time when his eminence was due to his glacial studies rather than to his work in ichthyology, which came later. I also include Bache, whose field is indicated as geography, because he was, in modern terms, an oceanographer. Incidentally, it was at the first meeting of the association held in Washington, D.C., in 1854, that Bache, then superintendent of the Coast Survey, announced the results of the measurements of ocean temperatures in and near the Gulf Stream, made under his direction.

This preponderance of geologists in the administration of the AAAS—there was no "permanent secretary" or "executive officer" in those days—was in part a carry-over from the "parent body," but it was even more a result of the great responsibility that many geologists had accepted for ensuring the success of the broadly inclusive organization, which seemed to them essential for the welfare of both science and nation. Geologists continued to play this leading role for another 40 or 50 years. (Some of these men are shown in Figs. 2 to 5.) Divide the list of 112 presidents into two equal parts. Among the first 56 there are 21 geologists; among the second 56 there are only five (or six if Isaiah Bowman is considered to be a geologist rather than a geographer).

I have counted as geologists not only Agassiz, as explained above, but also Edward D. Cope and O. C. Marsh; the former is listed as a zoologist rather than as a paleontologist like the latter, his bitter rival in the discovery and naming of fossil vertebrates. I have also counted two others, in addition to Bache, whose fields are indicated as geography. J. W. Foster was for a time associated with J. D. Whitney in the study of the Precambrian system in the Lake Superior region, and his address as retiring president indicated his later concentration upon paleoclimatology; Julius E. Hilgard was a geodesist and cartographer. It should be noted, moreover, that the "21 geologists" in my statistics are in reality only 20, inasmuch as William B. Rogers is listed twice, having been elected as the 26th president in 1875, after serving as "acting president" for the first meeting in 1848.

Even so, the contrast between the two halves of the list of presidents is great enough to have real significance and to call for explanation. It is undoubtedly related to the establishment in 1888 of the Geological Society of America, one of the first completely autonomous national societies of specialists in a single scientific discipline to be organized in the United States. It was not that geologists had suddenly become clannish and no longer wanted to rub shoulders with their colleagues in other fields of science, nor that they had lost interest in the aims and objectives of the association in general. The fact that for many years the meetings of section E (geology and geography) of the association have consistently been listed as joint sessions of the section and of the Geological Society of America and that abstracts of section E papers are still published in the *Bulletin of the Geological Society of America* is sufficient evidence that other reasons must be found.

Defined Disciplines

Although there was widespread interest in geology during the first half of the 19th century and many important contributions to this particular science were embodied in papers presented by professional geologists at meetings of the AAAS between 1848 and 1888, it was not until the last third of that century that the profession of geologist became clearly recognized and that professional standards for that vocation were developed. It is one thing to have sufficient interest in geology to become a member of section E or even to make a sufficiently "meritorious contribution" to geology to become a fellow of the AAAS; it is quite another thing to have adopted geology as a vocation and to have met the standards of preparation for its practice so as to be worthy of election as a fellow of the Geological Society of America. Professional status had at least a little influence upon the decision to set up the Geological Society of America as a professional society.

Then, too, there was in the 1880's a real problem with regard to publication. The *American Journal of Science* could not possibly meet the expanding needs of all the sciences. The *Proceedings of the AAAS* were drastically limited by meagre finances. Geologists wanted a journal of their own, in which they could communicate with each other, undistracted by reports directed to workers in other fields of science. The Geological Society of America was to have a *Bulletin* to meet this need.

Many important, highly technical, and narrowly specialized contributions to knowledge had been made by geologists at meetings of the AAAS. The annual meetings during the years 1848 to 1888

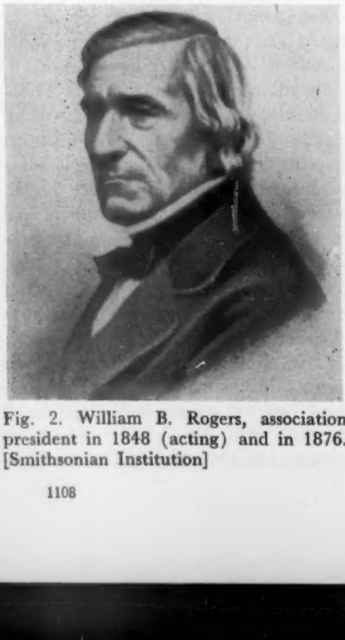


Fig. 2. William B. Rogers, association president in 1848 (acting) and in 1876. [Smithsonian Institution]

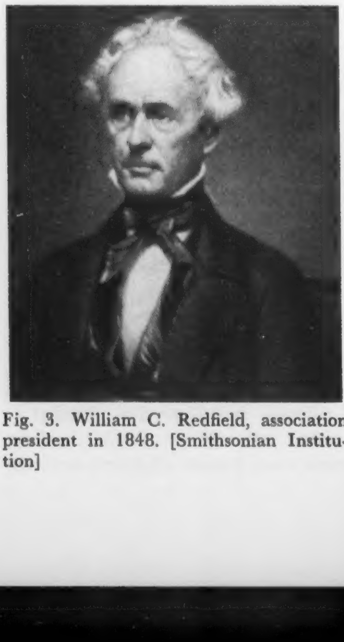


Fig. 3. William C. Redfield, association president in 1848. [Smithsonian Institution]

provided a platform from which eminent leaders in geological research could speak to their colleagues and a forum in which new ideas could be critically discussed. I have space for only a few of the many references that might be made. It was at the Montreal meeting in 1857 that Charles Whittlesey reported his initial studies of the former shore lines of the Great Lakes, one of the abandoned beaches of which was later named for him. The presidential address of James Hall at that same meeting was of such significance in the development of geology as a science that Mason and I included a portion of it in our *Source Book in Geology*. In 1859, T. Sterry Hunt contributed a paper at the Springfield, Massachusetts, meeting that, for the first time in North America, directed attention to the origin of evaporites among sedimentary rocks. Louis Agassiz announced in 1870, at the Troy, New York, meeting, his observations "On the former existence of local glaciers in the White Mountains." At the Hartford, Connecticut, meeting in 1874, G. K. Gilbert stressed the recency of volcanic activity in the western states, and John Muir reported his studies of the "Formation of mountains in the Sierra Nevada." J. W. Dawson's address as retiring president at the Minneapolis meeting in 1883 sketched the "Unsolved problems in geology" as he saw them at that time. At the Buffalo meeting in 1886, T. C. Chamberlin marshaled the evidence then known for multiple glaciation during the great ice age. In his address as retiring president at the Madison meeting in 1893, Joseph LeConte surveyed sagaciously the "Theories of the origin of mountain ranges."

On the other hand, the majority of the papers presented by geologists during those 40 years indicate that their authors were very conscious of the presence in their audiences of many persons not well trained in the science of geology and not competent to follow its increasingly specialized vocabulary. In the 1880's vocabulary barriers between the sciences were by no means as noticeable as they are today, but the trend toward their erection was beginning to manifest itself. Certainly, when, in 1888, the geologists in the AAAS organized their own separate society of specialists in a single, well-defined discipline, they were meeting what seemed to be a clear need and were blazing a trail that has been followed by many others since then.

The Botanical Society of America was organized in 1894, the American Society of Zoologists was formed in 1902 by the fusion of three older societies dating back to 1890, and the Association of American Geographers came into existence in 1904. The organization of these and many other professional and promotional societies posed many problems, both personal and institutional, relative to the relationship of the new societies with the AAAS. Most of the scientists involved soon found that, where loyalties were concerned, they were developing symptoms of schizophrenia. They recognized the different values, separate but possibly equal, of membership in the broadly inclusive Association for the Advancement of Science, on the one hand, and in the narrowly restricted, highly professional society, on the other. Conflicting schedules of meetings in widely separated localities were almost inevitable. Few individuals could afford the time for carrying out official organizational responsibilities in more than one society.

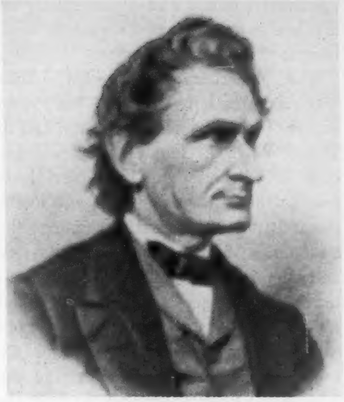


Fig. 4. James D. Dana, association president in 1854. [Smithsonian Institution]

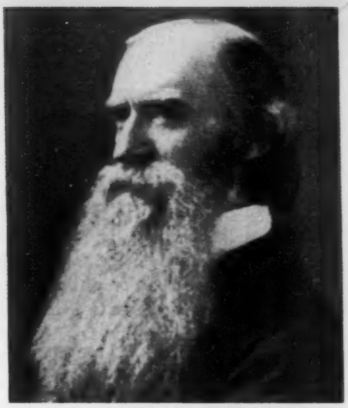


Fig. 5. J. S. Newberry, association president in 1867. [Smithsonian Institution]

Dual Membership

These problems have for the most part been solved, from the personal point of view, in the obvious way. Most scientists —geologists or others—have maintained their memberships in both the AAAS and the specialized society of their discipline. But they have limited their organizational activity to one or the other. As a rule (this is certainly true of geologists), the great majority have chosen the professional society rather than the association as the place in which they prefer to do their organizational chores. This seems to be the reason for the comparative dearth of geologists among the last 56 presidents of the AAAS. Election to that high post has been based, if I may say so, not so much on preeminence in one's field of scientific research as upon prior service to the association. Nearly every one of the last 15 or 20 presidents has climbed the ladder to that topmost rung from service on a sectional or other committee through at least one term on the executive committee or board of directors.

From the institutional angle, these problems of relationship have also been solved, equally well but in not nearly so inevitable a way. At the present time the administration of the AAAS, its fiscal affairs, and its strategy and tactics are actually in the hands of official representatives of the affiliated organizations, of which there are now 285, and of which most are the professional societies, each specializing in some one scientific discipline or segment thereof. These representatives constitute approximately three-fourths of the membership of the council of the association, the body responsible for policy making and for selecting officers and directors. Thus, from one very significant point of view the AAAS is the service organization for scientists otherwise banded together in disparate groups representing various segments of scientific disciplines according to their special interests and training.

But this is by no means all of the picture. The 18 sections of the AAAS continue to provide forums for the presentation and discussion of highly technical subjects far out on the periphery of the expanding frontier of research, where only specialists can fully comprehend their recondite significance. Witness the program for the joint session of

AAAS section E and the Geological Society of America, with its symposium on experimental geology. With the great increase in the number of geologists in recent years and the emphasis upon quantitative rather than merely qualitative observations in both field and laboratory, the pressure for time at the annual meetings of the Geological Society of America has become almost unbearable. Joint sessions with section E help notably to relieve that pressure, as do also the meetings of the state academies and the many local geological societies that have been formed in various parts of the country. There is plenty of room for all.

Specialization and Coordination

But the 20th century trend in science is not without its problems, too. The "settees" of "natural history" or "natural philosophy" in our institutions of higher learning were long ago broken down into "chairs" of geology or physics or chemistry or zoology, and so on. More recently those chairs have been splintered to provide "footstools," of (for example, in geology) petroleum geology, micropaleontology, geomorphology, sedimentology, petrology, seismology, and so on. There is much truth in the cliché that a scientist is "someone learning more and more about less and less." No longer does the label "geologist" tell the world what a man is doing to earn a living; a much more precise designation than that is now required.

Not many years elapsed after the birth of the Geological Society of America in 1888 before it too was holding concurrent sessions of subordinate, more narrowly specialized, groups at its annual meetings. In swift succession in subsequent years, such national organizations of specialists as the Paleontological Society, the American Association of Petroleum Geologists, the Mineralogical Society of America, the Seismological Society of America, the Society of Economic Geologists, the Meteoritical Society, the Society of Economic Paleontologists and Mineralogists, and the Association of Geology Teachers came into existence. Such specialization is, of course, a good thing; it is here to stay. It must, however, be balanced by a complementary development, else, pushed to the extreme, it may produce unfortunate results. Sooner or later, in science, analysis must be followed by synthesis. The value of cross-fertilization of highly specialized minds and of interdisciplinary research has been abundantly demonstrated in the last 30 years.

The American Geophysical Union was established in 1919 and has grown rapidly in membership since the end of World War II. The Geochemical Society is still an infant, but a very lusty one. In the activities of each, and in the research pursued by their members, the boundaries between geology, physics, and chemistry are being erased, even as those between geology and biology had long before been blurred by the paleontologists. Especially significant was the organization, a dozen years ago, of the American Geological Institute to coordinate certain phases of the activities of its sponsoring bodies, the ten major national societies of the devotees of earth science. Its primary functions are in the areas of public relations and communication, and thus only indirectly in that of promoting research. It therefore strives to do for geology in particular one of the things that the American Association for the Advancement of Science was originally designed to do for science in general.

Thus, we geologists find ourselves today in the midst of an extremely complicated network of interlocking, loosely coordinated, differentially specialized, and variously structured organizations. It is not easy to find one's way through the maze, or to decide—especially when the notices of annual dues arrive—where one's loyalties should be directed. Fortunately there are enough of us now to provide the necessary manpower to keep all essential organizations in a state of healthy vigor. Certainly, each of those I have named in this article has an important function to perform and is currently needed.

Not the least of these functions is involved in the relationship of geology and geologists to the AAAS. Here, of course, geologists should join with their fellow workers in all other scientific disciplines "to improve the effectiveness of science in the promotion of human welfare and to increase public understanding and appreciation of the importance and promise of the methods of science in human progress." These are also important functions of the American Geological Institute insofar as geology is concerned. But geology cannot possibly enjoy a favorable climate of public opinion in splendid isolation from the other sciences. Here is just another instance of "united we stand, divided we fall." Through the AAAS we geologists must work together with other scientists to accomplish those aims of the all-inclusive association. This means that the channels of communication must be kept open, not only between geologists tempted to confine their activities within one or other of the increasingly specialized compartments into which our science is now being fragmented, but also across the more obdurate barriers that threaten to separate us from the similarly specialized workers in the subdivisions of other major scientific fields. Participation in the meetings of the AAAS and support of its other activities is an obvious, effective means to that end.

From Analysis to Synthesis

Finally, I want to make a distinction between the trend in modern science toward interdisciplinary research, to which I have already referred, and the need for multidisciplinary studies which accelerate the progress of science from analysis to synthesis. The former is exemplified by much of the current work in geophysics and geochemistry. The geologist acquires tools and techniques developed by physicists and applies them in his investigations of subsurface structures and materials. The results have practical value and sometimes far-reaching significance in our thinking about earth history and earth processes. Figuratively speaking, interdisciplinary research brings together a few of the tips of the branches of the tree of knowledge. Multidisciplinary studies, as I see them, involve the deeper quest for underlying verities, the broader view that considers the whole as something more than a mere aggregation of its parts, the endless search for meaning as well as understanding. This kind of research works from the tips of the branches of the tree of knowledge inward to the trunk and downward to its roots. It may indeed involve philosophy as well as science, or at least it is probably best prosecuted by scientists with a philosophical turn of mind. Certainly it is at the roots of the tree of scientific knowledge that the unity of science is most likely to be apparent.

The expansion of the Association of American Geologists to include all naturalists and the subsequent transformation of that organization into the American Association for the Advancement of Science was the work of geologists deeply concerned for multidisciplinary

research, although they probably never used those words. Not only is geology inherently multidisciplinary in its very nature, because of its dependence upon physics, chemistry, and biology and its relations with astronomy and meteorology, but those leaders in our science a century and more ago were men with a definitely philosophical bent. In a sense, the cycle of the history of science is even now coming full circle. Enlightened and inspired by such contacts with other scientists as those provided by the AAAS, geologists today and tomorrow may make contributions to human welfare far more valuable than even the discovery of new oil fields or additional bodies of uranium ore.

Reference

1. H. L. Fairchild, *Science* 59, 365 (1924).

Transliteration of Russian

Gregory Razran

On the last pages of the 1955, 1956, and 1957 index numbers of the *Mathematical Reviews* is given a table of seven different systems of transliteration of Russian, including the systems used by the U.S. Library of Congress, by *Science Abstracts*, by *American Slavic and East European Review*, and by *Mathematical Reviews* itself. No comment is offered and no question is asked about why there should be so many systems or why the *Mathematical Reviews* needed to set up one of its own. Moreover, the table is of course not—and admittedly not intended to be—complete. The British Museum, the Slavonic Division of the New York Public Library, the Library of the New York Academy of Medicine, the Institute for the Study of the U.S.S.R., *Biological Abstracts, Chemical Abstracts*, and, above all, the *U.S. Government Printing Office Style Manual* all use systems that are in some respects different from each other and different from each of the systems in the table of the *Mathematical Reviews*. Indeed, essentially the widest difference in transliteration is that between (i) the system used by the Library of Congress and (ii) the one recommended by the Government Printing Office *Style Manual*. The former, for instance, resorts to no less than 11 diacritically marked letters while the latter is content with only one such marking—the dieresis over *e*, which, too, the Government Printing Office manual suggests, may be omitted whenever it is omitted in Russian (as it often is).

Clearly, use of this multiplicity of systems and the resulting waste and confusion need not continue. The multiplicity persists indeed only in scientific periodicals and in library catalogs and publications. The daily press, popular magazines, and by far most current translations of books seem to evolve gradually a more or less uniform system. One does not find, for instance, in these latter media the *Mathematical Reviews*' *Ȟruščev* and *Čerenkov* or the Library of Congress' *KHrushchev* and *CHerenkov* (with ligatures over *KH, CH*, and *shch*) for familiar *Khrushchev* and *Cherenkov*, to name only two common examples and two science-and-library systems of transliteration. Moreover, it should in general be noted that transliteration divergences exist only with respect to 13 of the 33 letters in the modern Russian alphabet: six consonants, six vowels, and a semivowel. *Bulganin, Pasternak*, and even *Pavlov* present no problem (Pawlow and Pavloff are quite obsolescent by now). But let me detail briefly the argument and the suggestion for uniformity.

Consonants

Use of ligatures, multiple capitals, inverted circumflexes, and the letters H, J, *and* TZ. The Library of Congress system uses ligatures over *zh, kh, ts, ch, sh*, and *shch* in transliterating Russian ж, х, ц, ч, ш, and щ (it also uses ligatures for some vowels, but this will be taken up later) and in addition capitalizes the two —in one case, four—letters when they occur initially. The rationale of the practice is presumably that of facilitating library cataloging and filing by indicating that the English combinations of letters correspond to single Russian letters. But, plainly, this limited and doubtful advantage must be pitted against the fact that ligatures and extra capitals are both expensive and unesthetic, add nothing from the standpoint of approximate pronunciation, and, indeed, have hardly ever been maintained consistently. The Library of Congress itself does not use ligatures in its *Monthly List of Russian Accessions*, nor does the *Current List of Medical Literature* published by the National Library of Medicine. Why, then, not give up the cumbersome practice altogether and avoid confusion and expense?

Several systems, notably the *American Slavic and East European Review* and the *Mathematical Reviews*, use *ž, č, š*, and *šč*, instead of *zh, ch, sh*, and *shch*, in transliterating the corresponding Russian letters. But, again, there is the problem of expense and esthetic appearance, to which should be added the even more important consideration of the average reader's unfamiliarity with the meaning of these marks and consequent gross mispronunciation. A good number of my colleagues—even the literary ones —pronounce the name of the famous Czech dramatist Čapek as "Kapek" and not, as they should, "Chapek." Besides, in general, diacritical marks are alien to both Russian and English, the former utilizing them only in й and occasionally in ё, and the latter resorting to them even more rarely.

Finally, there is the use of *h* instead of *kh* for Russian х by the *Mathematical Reviews*, of *j* instead of *zh* for Russian ж by the Library of the New York Academy of Medicine, and of *tz* instead of *ts* for Russian ц by the Slavonic Division of the New York Public Library. And here the inadequacies are even more evident. English *h* does not have the sound of Russian х; the French, and not the English, *j* is equivalent to Russian ж

The author is professor of psychology at Queens College, Flushing, N.Y.

(English *z* in azure); while *tz* is an impossible combination phonetically, a voiceless *t* with a voiced *z* (our own *quartz* notwithstanding). True, *kh* and *zh* do not equal the respective sounds of Russian **х** and **ж**, either; yet, they at least have the advantages of indicating the existence of a separate sound and of long-standing usage (think of Zhukov, Kharkov, and so on).

In fine, it is suggested that the following transliterations be consistently used for the now multiply transliterated six Russian consonants **ж**, **х**, **ц**, **ч**, **ш**, and **щ**: **ж**, *zh*; **х**, *kh*; **ц**, *ts*; **ч**, *ch*; **ш**, *sh*; and **щ**, shch.

Vowels

Letters **Ю**, **Я**, *and* **Ы**. The letters **ю** and **я** are, respectively, pronounced almost exactly as *yu* in *yule* and *ya* in *yard* and should be so transliterated. The *iu* and *ia* of the Library of Congress are, despite the ligatures, likely to be disyllabized in accordance with English usage, while the *ju* and *ja* of the *American Slavic and East European Review* are sure to be mispronounced by readers unfamiliar with, or unmindful of, phonetic designations.

English *y* might well be used to transliterate also Russian vowel **ы** which roughly sounds as *y* in *rhythm* (only roughly, though). Little confusion will result from this use of *y* as both a vowel and a semivowel: Russian **ы** occurs typically only between consonants and at the end of words, never initially or after a vowel, besides the fact that *y* serves a double, vowel-semivowel function also in English and in French. Hence, the *ȳ* of *Science Abstracts* and the *ï* of *Applied Mechanics Review* are unneeded and cumbersome (in the very rare cases of **ы** occurring before a vowel, the Russian "hard" mark, later transliterated as a double apostrophe, used in Russian as a separation mark, might be utilized to indicate that two vowels are involved).

Е, **З**, *and* **Ё**. At the beginning of words and after vowels and the "soft" and "hard" marks, the **е** is clearly pronounced as *ye* in English *yes* and should be transliterated as *ye* and not merely *e*. *Yesenin, Andreyev, polnoye sobraniye, zdorov'ye,* and *s"yezd* will be pronounced fairly correctly by any English reader, while *Esenin, Andreev, polnoe sobranie, zdorov'e,* and *s"ezd* (infra for the transliteration of the "marks") will not. On the other hand, while Russian **е** denotes palatalization also of preceding consonants, this palatalization is varying and often very slight, so that transliteration of Russian **е** after consonants by English *e* alone is quite adequate. Hence, *Lenin, Turgenev, Cherenkov,* and *Belorussia* rather than *Byelorussia. Soviet,* however, might be left as an exception—the only exception—because of its inveterateness, though in adjective form *Sovetskoye, Sovetskaya,* and *Sovetsky* (*Sovetskiĭ*) may be preferred.

Russian **э** invariably approximates English *e* in *else* and should be transliterated by plain *e* rather than by *ė*, *è*, or *é*, as it is in a number of different systems. The use of *ye* for Russian **е** at the beginning of words and syllables obviates any significant confusion between the rendering of **э** and **е**.

The **ё** in Russian is pronounced as *yo* except after letters **ж** and **ш** where it is sounded as *o*, and should thus be transliterated as *yo* or *o*. Leaving it as *ė* perpetuates a gross mispronunciation (note that the Russian ballet **Берёзка** is rendered correctly in the daily press as *Beryozka* and not *Berëzka*.

Semivowel

After **а**, **о**, and Russian **у** (English *u*), **й** is clearly pronounced like the *y* in the English word *boy*, while the combination **ей** sounds like the *ey* in the English word *they*. English *y*, and not *ĭ*, is thus the most appropriate letter for transliterating **й**.

However, when **й** occurs after **ы** or **и** (English *i* in *machine*), it is almost silent, which, added to the fact that *yy* and *iy* are awkward combinations, suggests that the **й** be omitted here altogether. **Белый** may thus be transliterated as *bely* and **синий** as *sini*. Note the rendition in the daily press of **Новый Мир**—the Soviet literary magazine in which Pasternak was recently attacked—as Novy Mir and not as Novyi, Novyy, Novïi and Novyj Mir, the way the systems of the Library of Congress, the Government Printing Office, *Applied Mechanics Abstracts,* and *American Slavic and East European Review* would respectively have it.

Again, in the combinations **-ский** and **-кий**, notably in Russian surnames, the suggested transliteration is *-sky* and *-ky* and not *-ski* and *-ki* both because *y* and not *i* is our typical final letter and because *-sky* and *-ky* help distinguishing Russian surnames from Polish ones which end in *-ski* and *-ki*.

Other Letters

"Soft" and "hard" marks **ь** *and* **ъ**; *Genitive* **-ГО**. The "soft" mark serves in Russian as an indicator of a preceding palatalized consonant as well as a separator of syllables; the "hard" mark functions only as a separator. For some time, the "soft" mark has been transliterated as an apostrophe, by almost all systems, but there has been no consistency with respect to the "hard" mark. My suggestion is that the Library of Congress' rendition of the "hard" mark as a double apostrophe or quotation mark be accepted. *Science Abstracts'* practice of a downward single quote for the "hard" mark and of an apostrophe for the "soft" mark is difficult for typescripts where the two are not differentiated.

The ending **-го** (English *go*) in the genitive case is pronounced in Russian as *vo* and should be so transliterated.

Table 1. Complete and uniform transliteration of Russian into English.

Russian	English	Russian	English	Russian	English
а	*a*	к	*k*	х	*kh*
б	*b*	л	*l*	ц	*ts*
в	*v*	м	*m*	ч	*ch*
г	*g*; Genitive **-го**, *-vo*	н	*n*	ш	*sh*
д	*d*	о	*o*	щ	*shch*
е	*ye* at beginning of syllables; *e* elsewhere	п	*p*	ъ	"
ё	**уо**; **о** after **ж** and **ш**	р	*r*	ы	*y*
ж	*zh*	с	*s*	ь	'
з	*z*	т	*t*	э	*e*
и	*i*	у	*u*	ю	*yu*
й	*y*; omit after **и** and **ы**; **-ский** = *-sky*, **-кий** = *-ky*	ф	*f*	я	*ya*

Summary

The objective of any system of transliteration is obviously to convey to the reader as closely as possible the phonetic value of the transliterated material. Barring phonetic transcriptions, this objective is doubtless best accomplished when (i) minimum use is made of extra marks and extra letter combinations that of necessity are arbitrary, unclear, and confusing to many readers, and when, of course (ii), there is only one uniform system and not a variety of varying ones. A detailed analysis reveals that present-day practices of transliterating Russian into English by no means conform to these desiderata, but that they could readily be made to do so. With only two extra letter combinations, *zh* for **ж** and *kh* for **х**, and a single and a double apostrophe for the "soft" and "hard" marks, a very close approximation of Russian phonology may be attained through a discriminating use of English as is. A complete and uniform transliteration of Russian into English, including the noncontroversial letters, is shown in Table 1.

Note added in proof. After this article was written, I came across the transliteration system of the *Current Digest of the Soviet Press,* a system the stated rationale and objective of which are much the same as those advocated here. However, the *Digest's* system clearly gets away from "approximating Russian sounds" in transliterating (i) **я** after **и** by *a*, (ii) **ь** and **ъ** before vowels by *y*, and in (iii) omitting **ь** altogether before consonants and at the end of words. The **прия-** in **приятно** certainly differs from the **пря-** in **прятать,** as do also the **дья-** in **дьякон** from the **дя-** in **дядя,** the **объя-** in **объяснять** from the **обя-** in **обязать,** and the **поль-** in **полька** from the **пол-** in **полка.** The last pair of words, furthermore, illustrates the fact that the *Digest's* system obliterates distinctions between Russian words of totally different meaning and etymology, a fact manifesting itself particularly often when the omission of the **ь** is at the end of words and no difference is thus obtained between the transliteration of such words as **брат** and **брать, ел** and **ель, пыл** and **пыль, цел** and **цель** and many others —as well as between the transliteration of the third person present (and future) singular and the infinitive in **-ить** class verbs. Again, the *Digest's* transliteration of **ю** and **я** after **ы** by *iu* and *ia* obviously destroys the uniformity of the rendition of the two letters, whereas my suggestion that in general a double apostrophe—the transliteration of **ъ**—be inserted between transliterated **ы** and succeeding vowels not only preserves this uniformity but also provides for the case of Russian **у** (English u) after **ы** as in **выучить** (the *Digest's* system does not mention **у** after **ы** and is not specific about **е** after **ы**).

News of Science

House Science and Space Committee Holds Hearings to Establish the Scope of Its Responsibilities

Since the opening of Congress last January the House Committee on Science and Astronautics has been holding a series of hearings covering a wide range of governmental scientific activities. Witnesses from a number of federal agencies—for example, the National Science Foundation, the National Aeronautics and Space Administration, and the National Bureau of Standards—have appeared before the committee in recent months. Most recently, Alan T. Waterman, director of the National Science Foundation, gave testimony on the activities of his organization.

Two purposes are being accomplished, according to observers. First, the 25 members of the committee, many of them new to the House of Representatives, are becoming acquainted with the agencies, the administrators, and the scientific activities that make up their area of legislative interest. Information derived from the testimony is being compiled into a number of reports to which the committee members can refer during future deliberations on matters affecting the various agencies. The second purpose is to define, in rough outline, the committee's jurisdictional range.

Space Committees

The House Committee, which succeeds the Select Committee on Astronautics and Space Exploration, has a counterpart in the Senate which was set up just 1 month earlier. The establishment of similar permanent committees in the two chambers of Congress at roughly the same time is a rare event in the history of the Legislature. The last such instance was in 1892, when both chambers established committees to deal with interior and insular affairs. The chairman of the new House group, Overton Brooks (D-La.), gave up his 22-year seniority ranking as a member of the Armed Services Committee to preside over the activities of the Science and Astronautics Committee.

The new group has permanent status as a standing committee. It will benefit from the work done by its predecessor, the Select Committee, which issued a number of publications on space and had a role in formulating the legislation that established the National Aeronautics and Space Administration. There is considerable continuity with the old group, with respect to committee members and staff members. John W. McCormack (D-Mass.), for example, served as chairman of the Select Committee and is now the second ranking Democrat in the new group. Other long-term members are Joseph Martin (R-Mass.) and Walter Riehlman (R-N.Y.).

Jurisdictional Range

The primary concern of the committee during this early period of its existence is its jurisdictional range. Jurisdiction over the National Science Foundation, the Space Administration, and the National Bureau of Standards was explicitly assigned to the committee in House Resolution 580, which set it up. However, other areas of responsibility were also indicated, in less explicit language. These include "scientific and astronautical research and development generally . . . outer space . . . and science scholarships." Hearings held earlier this year on the Nike missile program repre-

sent the efforts of the committee to define more exactly these general terms. Other hearings have been concerned with scientific education, weather reconnaissance and control, intelligence on Russian activities, and many other matters. In time, this exploratory activity, which is under the constant scrutiny of other Congressional committees, will help determine the fields of inquiry which the whole Congress will accept as the proper province of the House group. One other end essential to political life, is also served. The committee and its members, because of the topicality of its subjects and the stature of many of the witnesses, receive rather wide publicity.

Future Hearings

Although the committee does not issue schedules of future hearings, it is expected that a broad pattern of investigation will continue in the future. According to informed sources, hearings may be expected on computers, solid-state physics, and oceanography. The oceanography hearings are expected to include examination of the recent proposal of the National Academy of Sciences for a 10-year program of ocean study, including the construction of a number of research vessels. A bill embodying the Academy's recommendations is said to be in preparation. Another bill, reflecting an idea first suggested by Wernher von Braun, is also expected to come from the committee. This is the so-called "tithe" bill. Under its provisions, a 10-percent increase would be made on every research and development contract let by the Government, this amount to be earmarked for basic research in the field to which the contract is directed. It is estimated that passage of the bill would add approximately $600 million to the country's annual expenditures for basic research.

Nuclear Reactor Housed in 190-Foot Sphere

The 300-ton reactor for the Commonwealth Edison Company's Dresden Nuclear Power Station is now being installed at the plant near Morris, Ill. The reactor vessel is 42 feet high and 12 feet in diameter. Its walls are 5½ inches thick, and are made of low-carbon steel with an interior lining of ⅜-inch stainless steel. Built by the New York Shipbuilding Corp., the unit was shipped by barge from Camden, N.J., over a circuitous 3600-mile route.

Dresden Station is expected to be ready for regular service by mid-1960. The General Electric Company is building the plant for a contract price of $45 million.

U.N. Surveys Development of New Sources of Energy

Notable progress in the last 2 years in developing applications of solar, wind, and geothermic energy is reported in a United Nations study on new energy sources. The report, prepared at the request of the U.N. Economic and Social Council, was considered by the council session that opened in Mexico City on 7 April.

Besides describing technical and other developments in the use of energy from the sun, the wind, and the earth, the report proposes the scheduling, in about 2 years, of an international conference on new sources of energy other than the atom. The report also suggests that the agenda for such a conference should focus attention on applications rather than on discussion of scientific principles and basic research.

In a summary of recent developments, the report says that direct conversion of solar energy to electricity by means of solar batteries and by thermoelectric converters is rapidly being advanced.

Work also continues, though at a slower rate, on the use of solar energy in steam-raising, air conditioning, refrigeration, and water distillation. Less progress appears to have been made in developing solar-heat storage, solar engines, and solar furnaces for industrial production. A significant aspect of recent developments has been the increasing attention given to new materials, such as plastics, suited for use in solar equipment.

In the field of wind power, the past 2 years have been a period of "consolidation and of transition from experimentation to applied research and commercial use." In underdeveloped countries, wind-power surveys have led, in a few cases, to the installation of the first modern wind-power plants. The linking of large wind-power plants to local or country-wide grid systems is being explored. Most of the work on this is being done in Europe.

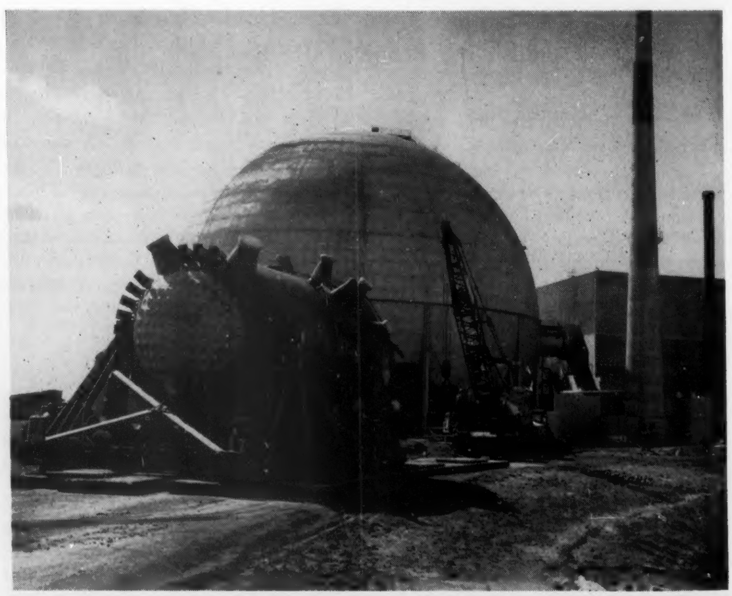
As regards geothermic power (natural steam and hot water), the report notes that production of electricity from this source—limited 2 years ago to Italy—is being started in other countries. The greater interest in geothermic power is also reflected in the search for and discovery of new geothermic fields.

In the section of the report describing development in each of the three new energy fields, the following points are covered.

Solar Energy

Introduction of new devices and materials has helped improve efficiency and reduce costs in practical application of solar energy. The design, manufacture, and installation of solar water heaters are proceeding in Australia, the Belgian Congo, Burma, Chile, Egypt, France, French West Africa, Israel, Italy, Japan, New Zealand, the Union of South Africa, the United States, and the U.S.S.R.

Solar cookers may become a common sight in some countries, where women are accustomed to being out-of-doors, where the main meal is eaten during the



Nuclear power reactor just before it was moved into a steel sphere at a plant near Morris, Ill.

day, and where the introduction of the cooker is undertaken by persons familiar with the psychology of the people. First attempts to introduce solar cookers to villagers in less developed areas failed, largely because of the neglect of sociological factors.

The report mentions an experimental sun kitchen that was tested by the Heliolaboratory of the U.S.S.R. Academy of Sciences. It is estimated that such a kitchen, operating 250 days a year in sunny regions of the U.S.S.R., could save approximately 1000 kilowatt-hours of electrical energy.

Experimentation is also being carried on in several countries (such as Canada, Japan, and South Africa) in space heating and cooling. A number of solar-heated houses have been built in the United States. Investigations into solar air conditioning have also been carried out in a number of countries, and the U.S. has developed solar-energy cooling systems for livestock shelters.

Research into solar refrigeration has resulted in a solar refrigerator being devised in Israel, while in the U.S.S.R. and France ice-making machines based on absorption refrigeration have been constructed.

Experiments are also proceeding in a number of countries for applying solar heat for mechanical power and electricity. A helioboiler is being constructed in Israel, and Soviet scientists have drawn up plans for a large solar power installation to be erected in the Ararat Valley of Armenia.

As regards direct conversion to electricity, most of the progress so far achieved, it is reported, has been related to the discovery of new materials for use in generation by means of thermocouples and photovoltaic devices. The latter have been used in artificial satellites.

Of importance to arid regions are developments in the use of solar energy for production of fresh water. Several small units for distilling sea water or brackish water have recently been built in Australia, Italy, the African countries of the French community, and the United States. Larger pilot plants have been constructed in the United States and the U.S.S.R.

New methods of salt production by means of solar energy are being tried out in several countries and in some cases have been put to commercial use. The report mentions an economical and efficient method used in the Union of South Africa for separating common salt and Glauber's salt from natural brines. The use of solar reflectors to concentrate palm juice to produce unrefined sugar is reported from Burma and India.

Progress in using solar furnaces has been particularly rapid since 1956, says the report, and over 30 solar furnaces are operating throughout the world, most of them located in France, the United States, and the U.S.S.R. Solar furnaces are particularly useful as laboratory tools for research on fusion of rare metals, for the furnaces offer the unique advantage of complete purity in processing. They are also useful for testing metals for heat resistance—for examples, metals to be used in nuclear devices—and for small-scale mineral refining in remote locations.

Wind Power

The number of countries undertaking systematic research on wind power has been steadily increasing, the report states. Listed among these are: Israel, where a general wind survey has been completed and two small wind-driven electric generators have been installed; Spain, where surveys have been made with a view of using windmills for water pumping and for the desalinization of brackish waters; India, where testing stations have been set up to determine the potentialities of wind-driven plants for pumping water and generating electricity; Uruguay, where a survey of some 10 to 12 selected wind-power sites has been initiated; Burma, where studies on possible uses of wind-power are being made; and Pakistan, where wind measurements are being made to find favorable sites for water-pumping windmills.

While designs for wind-driven generators vary in different parts of the world, there is general agreement on several points, says the report. The tendency is to employ conventional, propeller-type machines which drive a generator through some form of gearing and to use a tower of the height necessary to give adequate ground clearance.

Small wind-power units (under 10 kilowatts) are now mass-produced in several industrialized countries and are used for radio and television relay stations, small residential areas, isolated resorts, pumping plants, navigation lights, and fog signals. An example of these is a medium-scale, wind-driven power unit developed in the U.S.S.R. It has a 25-kilowatt capacity and is used to supply electricity to villages and collective farms. Wind-driven generators for use with electrical networks have been tried out in Denmark, Algeria, the Federal Republic of Germany, Holland, the United Kingdom, and the U.S.S.R.

Geothermic Energy

Considerable progress made during the last 2 years in several countries in exploring, developing, and utilizing geothermic energy is reported. Whereas 2 years ago only one country (Italy) had geothermic power plants, today two others (New Zealand and the U.S.S.R.) are producing electricity by this means, and others expect to inaugurate plants in the near future. Additional geothermic fields have been discovered in France, Burma, Kenya, and the United States (southern California).

A number of geothermic resources in Mexico, having been evaluated by a U.N. technical assistance expert, are now under active development. In the West Indies, again after preliminary evaluation by a U.N. technical assistance expert, exploration drilling was begun on the island of Santa Lucia. Geothermic energy has been found at two places in El Salvador.

Iceland's considerable geothermic resources, long used for space heating, will be used for the production of sea salt; this will reduce imports of salt required in the country's fishing industry. The possibility of producing heavy water by means of geothermic energy has also been investigated in Iceland.

The first geothermic power plant in the U.S.S.R. has begun operation on the Kamchatka Peninsula, while the first units of a 293,000-kilowatt program have been inaugurated in New Zealand. Facilities for the latter are at Wairakei, where the average well depth is 2,000 feet and where wet steam is discharged from the wells with high intensity.

Recent Events in Radiocarbon

There have been several events recently in the field of radiocarbon.

Radiocarbon Supplement Established

The *American Journal of Science* has announced the establishment of a *Radiocarbon Supplement*, to be devoted wholly or largely to publication of radiocarbon date lists from laboratories in various parts of the world. Richard Foster Flint and Edward S. Deevey, Jr., are the editors.

Volume 1 of the *Supplement* will appear in May. Thereafter, one volume will appear each year. The office of the *Supplement* is the same as that of the *American Journal of Science* (Box 1905A, Yale Station, New Haven, Conn.); however, the *Supplement* will be separated from the *American Journal* and will be sent to a separate subscription list. The price of the first volume is $2.50.

Radiocarbon Association Formed

Radiocarbon Dates Association, Inc., a nonprofit corporation, has opened headquarters at Andover, Mass., with the generous assistance of the Wenner-Gren Foundation and the National Science Foundation. The organization was formed after an ad hoc committee had studied methods for developing and distributing edge-punched cards bearing

radiocarbon dates and a description of the samples assayed. The committee decided that the new record cards should also include the laboratory, laboratory number, method employed, and major scientific field concerned. The committee's suggestions have been followed, and a basic coding has been provided so that initial sorting of the cards is easily accomplished. There is room for each subscriber to set up an extensive code to sort the cards for his own research.

A survey indicated considerable demand for the cards, but the cost of production, $250 for a set of 5000 cards, resulted in a limited number of subscriptions. However, revision of the original plans and the generosity of the commercial houses involved has made it possible to proceed. The corporation is distributing sets of about 1000 cards each to subscribers, and there is the possibility that another 3000 cards can be delivered by the end of 1960. The remaining 1000 will be sent out when they are published.

Because the project is barely solvent, it is not going to be possible to print a surplus of these cards for nonsubscriber sale. Any organization that is contemplating purchase should communicate with Frederick Johnson, Radiocarbon Dates Association, Inc., R. S. Peabody Foundation, Box 71, Andover, Mass.

Center for Carbon-14 Determination

The International Agency for ^{14}C Determination (measurements of primary production in the sea), has been established at Charlottenlund Slot, Charlottenlund, Denmark. The agency is organized on a nonprofit basis. E. Steeman Nielsen, who is adviser on plankton research to the Danish Institute for Fisheries and Marine Research, is honorary supervisor, and the daily work is directed by Vagn Hansen of the same institute. The facilities of the agency are available to all scientific institutions in the world.

Manufacture of the carbon-14 ampoules that are used in experiments for measuring primary production in the sea requires a well-equipped laboratory and a scientist familiar with radioactive tracer work. The same is true concerning the measurements of the radioactivity of the filters containing the samples to be studied. Whereas large oceanographic institutions ordinarily have such an expert at their disposal, this is not true for many other marine laboratories.

This problem was discussed during the Symposium on Measurements of Primary Production in the Sea held at Bergen, Norway, in 1957 by the International Council for the Exploration of the Sea. An ad hoc working committee was appointed to consider the methods for the measurement of primary production. Among its recommendations which were adopted unanimously by some 80 symposium participants, was a paragraph that read: "It is suggested that a central agency be established, for example at Charlottenlund under the direction of E. Steemann Nielsen, which would provide standardized ampoules of ^{14}C, counting of ^{14}C samples, and calculation of carbon assimilation rates." In 1958 UNESCO provided funds for establishing the agency, which is now operating in space provided by the Danish Institute for Fisheries and Marine Research at Charlottenlund.

Radiotelescope under Construction

A team of ten students, directed by John D. Kraus of Ohio State University, is constructing an unusual radiotelescope under a National Science Foundation grant of $166,000. Two earlier grants by the foundation for this work have totaled $106,650.

The design, engineering, and construction of the two 360-foot-long antennas are done for the most part by the students, who work part time during the school year and on a full-time basis in the summer. Three nonstudent technical assistants are also employed on the project.

The new instrument is designed to be used in mapping radio sources in the sky at minimum cost. The installation will consist of a fixed parabolic antenna 360 feet long and 70 feet high; a flat, tiltable reflector 360 feet long and 100 feet high; and associated radio receiving equipment. The telescope is expected to go into operation in 1960.

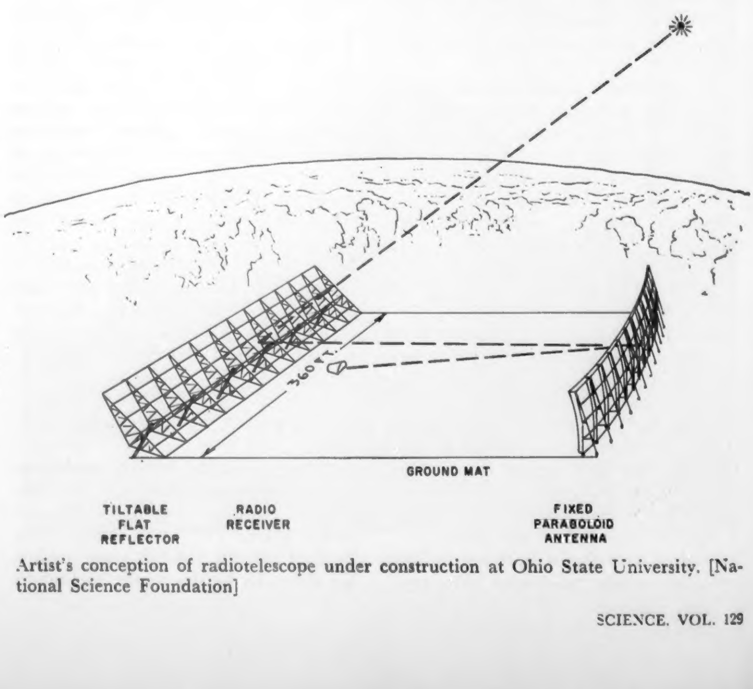
Soviet Science

Many reports, giving both accomplishments and proposals, have been published recently on Soviet scientific activities. Some of these are summarized here.

Two members of the United States Weather Bureau have reported that Soviet scientists have turned up evidence that a continental land mass lies below a great part of the ice-covered expanse of Antarctica. They said the "positive" evidence of a continent had been found by the Russians during a long, over-ice trek made in the latter part of 1958 from their main base at Mirny on the Knor Coast to the "pole of relative inaccessibility," a point about 1400 miles inland. During the trek the Soviet scientists made seismic soundings every 30 to 50 miles along the route. These indicated that the actual land mass started about 300 miles inland from the Mirny base camp.

Members of a group of astrophysicists which toured the Soviet Union last year reported that the U.S.S.R. is graduating about twice as many astronomers as the United States. They also gave their view that, although the United States now leads in astronomy, there is reason to believe that Russia may take the lead within 15 years.

Other scientific visitors to Russia report that Soviet mathematicians have made great progress in information theory and in cybernetics, two areas of mathematical study that were condemned on ideological grounds a few years ago. Work in the two fields is mostly theoretical because of the scarcity of large digital computers. Other observ-



Artist's conception of radiotelescope under construction at Ohio State University. [National Science Foundation]

ers commented on the same point, stating that Soviet computers were fewer in number, less reliable, and not as large as the computers commonly used here.

At a recent meeting of the Technical Council of the Soviet Ministry of Communications it was proposed that the development of a television relay satellite be made part of the current Seven-Year Plan. The proposal calls for the placing of a satellite in a "hovering" orbit, roughly 22,000 miles from the earth. The satellite, in orbit over the equator, would be so located that it would require one day to circle the earth. Because the earth itself rotates in that time, the result would be a satellite fixed in relationship to the earth. This could be used to relay television broadcasts to all points in the Soviet Union. One Soviet authority suggested that, on the basis of the state of rocketry in the U.S.S.R., such a project was "quite feasible." It is not known whether the proposal has been accepted by the Ministry.

Soviet scientists are reported to be planning to build a 240-inch telescope, the largest in the world. The design is said to have been completed, and plans call for the telescope to be in operation within 15 years, at a site in the Crimea. The largest now in operation is the 200-inch telescope at Mount Palomar, California.

Work of Council for Foreign Physicians Increasing

The number of foreign-trained physicians taking the qualifying examination of the Education Council for Foreign Medical Graduates is rapidly increasing. The council, with offices in Evanston, Ill., aids graduates of foreign medical schools in establishing their qualification to assume internships or residencies in United States hospitals.

Some 298 candidates took the first examination in March 1958; 844 in September 1958; 1772 in February 1959; and more than a thousand have already registered for the next examination on 22 September 1959. The number of centers where foreign medical graduates can take the examination overseas has also greatly increased. There were no foreign centers for the first examination, 30 for the second, and 44 for the third.

For the next examination there will be 15 centers in Latin America, 14 in the Far East, seven in the Near and Middle East, 13 in Europe, and one in Africa. In addition, examinations are held at various places in the United States.

In the last examination, 43.4 percent of the 1772 candidates won standard ECFMG certificates. Another 25.5 percent won temporary 2-year certificates, based on scores of 70 to 74 percent. Inadequate command of English played a major role in producing failure in the qualification examination in some of the foreign examination centers. There was one center in which three out of five candidates either failed or did very poorly on the English test. In the whole group of 494 physicians taking the examination in foreign centers, 45 showed serious inadequacy in their command of English. In contrast, among the 1278 foreign-trained physicians taking the English test in U.S. examining centers, none failed and only three did poorly. Applications for the next qualifying examination must be in the ECFMG offices at 1710 Orrington Avenue, Evanston, Illinois, by 22 June.

Indian Bird Collection

Two Harvard zoologists who spent a year and a half collecting birds in Nepal, Pakistan, and India, have returned with the largest collection of birds ever made on the Indian subcontinent. The new specimens fill a gap in the Harvard Museum's extensive collections of birds from nearly every region of the world. The birds will be invaluable not only in solving some problems in the classification of birds from this area but also in studying classification and evolution in Chinese birds, which are closely related to those from the Indian region. Raymond A. Paynter, Jr., associate curator of birds at Harvard's Museum of Comparative Zoology, and Melvin L. Bristol collected over 5500 birds, and some mammals, reptiles, and amphibians.

The expedition was cosponsored by the Peabody Museum at Yale University and the Museum of Comparative Zoology at Harvard, who will share the birds and other animals with the countries where they were collected.

Women in Science

The National Council on the Participation of Women in Science was organized on 21 March at a meeting in the Jefferson Hotel in Washington, D.C. Mary Louise Robbins, associate professor of bacteriology at the George Washington University School of Medicine, was elected chairman. Robert J. Rutman, of the John Harrison Laboratory of Chemistry, University of Pennsylvania, was elected deputy chairman, as was Murray Vernon King of Brooklyn Polytechnic Institute. Elizabeth Weisburger, National Cancer Institute, National Institutes of Health, was elected secretary; and Ethaline Cortelyou, technical editor, Atlantic Division, Aerojet-General Corporation, Frederick, Md., was elected treasurer.

The objective of the council is to encourage more extensive participation of women in science. The organization is the outgrowth of a conference on problems of women in science—sponsored by the American Association of Scientific Workers and Sigma Delta Epsilon, graduate women's scientific research association—that met on 29 December in Washington during the annual meeting of the AAAS. Arthur S. Flemming, Secretary of Health, Education, and Welfare, was the keynote speaker at the December meeting, which was attended by more than 150 women.

The chairman of the March conference was Melba Phillips, physicist at Washington University, St. Louis. Cosponsoring organizations were the Business and Professional Women's Foundation; National Federation of Business and Professional Women's Clubs, including the District of Columbia Federation; and the United States National Student Association. Official representatives were sent by the Women's Bureau of the Department of Labor; the National Science Foundation; Goucher College, Baltimore; Elmira College, Elmira, New York; and Smith College, Northampton, Mass.

NATO Oceanographic Center

The United States, in cooperation with eight members of the North Atlantic Treaty Organization, will establish this spring an international scientific center for oceanographic research in La Spezia, Italy, to be known as the SACLANT Antisubmarine Warfare Research Center [Supreme Allied Command, Atlantic]. It will be commissioned on 2 May in ceremonies at the Italian naval base at La Spezia, where Italy also has an oceanographic research establishment. Rear Admiral John T. Hayward, assistant chief of naval operations for research and development, has been a prime mover in the creation of the center, for which the United States will provide $2.5 million during the next 2 years.

Scientists will be recruited from the nine nations taking part in the project —the United States, Great Britain, France, Italy, West Germany, the Netherlands, Norway, Denmark, and Canada. At the outset only one or two investigators from each nation will participate, but the group is expected to grow.

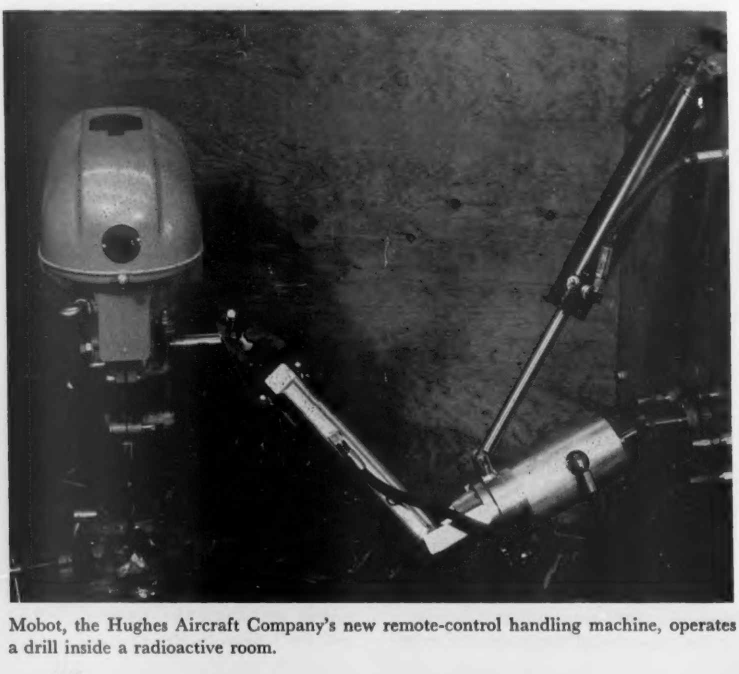
The new facility will be devoted primarily to basic oceanographic research, rather than to actual development of antisubmarine weapons. In particular, it will emphasize research on the characteristics of the relatively shallow ocean areas, such as are found in the Mediterranean and along the coasts of Europe and the United States.

The center will be directed by Admiral Jerauld Wright, NATO Supreme Allied Commander Atlantic, who will establish the basic lines of research. In addition, a council of scientists will be organized within NATO as a board of advisers.

Mobile Robot Operated by TV

A remote-control handling machine for use in radioactive laboratories has been developed by the Hughes Aircraft Company. The mobile robot, called Mobot, can lift, place, and invert dangerous radioactive materials, operate equipment, and use auxiliary tools such as wrenches, screwdrivers, hammers, and shears. Mobot functions electrically by cable or radio link. Sitting outside a shielded room, an operator watches Mobot's work on closed-circuit television. Television cameras mounted on the walls of the room provide an over-all picture of the environment, while cameras on top of the machine afford forward and rear-direction views and close-ups of the gripping device, pincers that can be adjusted to either a light touch or a 200-pound squeeze. A microphone enables the operator to hear the machine grasp an object.

Mobot was developed for Hughes' program of experiments to measure the effects of atomic radiation upon electronic components. This work is being carried out in the company's new underground nuclear laboratories.



Mobot, the Hughes Aircraft Company's new remote-control handling machine, operates a drill inside a radioactive room.

AAAS Socio-Psychological Prize

Through the generosity of an anonymous donor, the AAAS offers an annual prize of $1000 for a meritorious essay in socio-psychological inquiry. Previous winners of this prize and the titles of their essays have been: Arnold M. Rose, "A theory of social organization and disorganization"; Yehudi A. Cohen, "Food and its vicissitudes: a cross-cultural study of sharing and non-sharing in sixty folk societies"; Herbert C. Kelman, "Compliance, identification, and internalization: a theoretical and experimental approach to the study of social influence"; and Irving A. Taylor, "Similarities in the structure of extreme social attitudes."

The conditions of competition for the prize to be awarded at the 1959 annual meeting, Chicago, Illinois, 26–31 December, are as follows:

1) The contribution should further the comprehension of the psychological-social-cultural behavior of human beings —the relationships of these hyphenated words being an essential part of the inquiry. Whether the contributor considers himself to be an anthropologist, a psychologist, a sociologist, or a member of some other group is unimportant as long as his essay deals with basic observation and construction in the area variously known as social process, group behavior, or interpersonal behavior. For ease of reference in the rest of this statement, this general area will be called "social behavior."

2) The prize is offered to encourage studies and analyses of social behavior based on explicitly stated assumptions or postulates, which lead to experimentally verifiable conclusions or deductions. In other words, it is a prize intended to encourage in social inquiry the development and application of dependable methodology analogous to the methods that have proved so fruitful in the natural sciences. This is not to state that the methods of any of the natural sciences are to be transferred without change to the study of social behavior, but rather that the development of a science of social behavior is fostered through observation guided by explicit postulates, which in turn are firmly grounded on prior observations. It may be taken for granted that such postulates will include a spatial-temporal framework for the inquiry. It may properly be added that the essay should foster liberation from philosophic-academic conventions and from dogmatic boundaries between different disciplines.

3) Hitherto unpublished manuscripts are eligible, as are manuscripts that have been published since 1 January 1958. Entries may be of any length, but each should present a completed analysis of a problem, the relevant data, and an interpretation of the data in terms of the postulates with which the study began. Preference will be given to manuscripts not more than 50,000 words in length. Entries may be submitted by the author himself or by another person on his behalf.

4) Entries will be judged by a committee of three persons considered well qualified to judge material in this field. The judges will be selected by a management committee consisting of the chairman and the secretary of Section K and the executive officer of the AAAS. The committee of judges reserves the right to withhold the prize if no worthy essay is submitted.

5) Entries should be sent to Dael Wolfle, Executive Officer, American Association for the Advancement of Science, 1515 Massachusetts Ave., NW, Washington 5, D.C. Entries should be submitted in quadruplicate. Each entry should be accompanied by six copies of an abstract not to exceed 1200 words in length. The name of the author should not appear anywhere on the entry itself but should be enclosed on a separate sheet of paper which also gives the author's address and the title of his essay. Entrants who wish to have their manuscripts returned should include a note to that effect and the necessary postage. To be eligible for consideration for the prize that will be awarded at the 1959 annual meeting of the association, entries must be received *not later than 1 September 1959.*

News Briefs

The American science exhibits shown at the Brussels World's Fair have been collected and put on display at the Museum of Science and Industry in Chicago. The National Science Foundation, which was responsible for the creation and presentation of the original displays in Brussels, is sponsoring the exhibit in Chicago. The display units, which were prepared by hundreds of scientists at various university, government, and industrial research centers before shipment to Brussels, are grouped in four major categories in the current exhibit. These are American scientific research in the fields of the atom, the molecule, the crystal, and the living cell.

* * *

The whereabouts of Peking man, discussed in the 27 March "News of Science," is apparently not just a scientific issue, but a political one as well. In an article on Iraq that appeared last month in the *Washington Post,* Mary V. R. Thayer reports, when referring to the ambassador from mainland China:

"The diminutive Chinese Ambassador, Che-fang, bounces into every reception, immediately seeks some unfortunate Westerner to bait. His favorite gambit is to accuse Americans of stealing the Peking Man skeleton. Since few really know what happened to the Peking Man's bones, Chen Che-fang usually gets away with it."

* * *

According to a *New York Times* survey, only a small number of the scholarships that will be awarded this spring to high-school graduates will go to children of lower-income families. The scholarships, awarded by colleges, businesses, and organizations, are going in the main to sons and daughters of 'middle-income' parents, the study reports. Interviews with various college officials and examination of published studies indicate that, of those students who receive financial aid, only about 10 percent come from families that have incomes of $4000 or less. Other parts of the report state that because of financial and other barriers the nation is now losing the talents of 150,000 able youths a year from the lower-income families.

* * *

A new satellite-tracking range, designed to achieve extremely high accuracy, will begin operation on Long Island in May. The range will have three stations with approximately the same weather conditions and with the same time signals generating from one source. The three units will track and photograph the satellites at the same instant against a background of fixed stars. It is planned that the time signals will be obtained from the Brookhaven National Laboratory's atomic clock. The unusual accuracy of the new range will contribute significantly to the refinement of world geodetic surveys, according to one authority. Plans are being considered which would link the Long Island range with others on the East Coast, including the range at Cape Canaveral.

* * *

Charles H. Townes, professor of physics at Columbia University, has given his patent rights for the maser to the Research Corporation, New York, which was established by the late scientist and inventor, Frederick G. Cottrell. The corporation's total income is distributed among educational institutions for the support of fundamental research. The patent rights cover a variety of existing masers as well as those that are proposed or are now being constructed. Maser is a word that was coined by Townes, who supervised the building of the first maser in 1954. The word stands for "microwave amplification by stimulated emission of radiation."

* * *

Colleagues, friends, and former students of the late Robert Emerson, University of Illinois professor of botany, are establishing a memorial fund in his honor to provide financial assistance for graduate students working in the allied fields of photosynthesis, physics, chemistry, and biochemistry. Anyone wishing to contribute to the Robert Emerson Memorial Fund should send donations to University of Illinois Foundation, 226 Illini Union, Urbana, Illinois.

Scientists in the News

DONALD B. ZILVERSMIT, professor of physiology at the University of Tennessee, has been named the seventh Career Investigator of the American Heart Association. The Career Investigatorship provides $30,000 annually for outstanding scientists throughout their productive lives. Zilversmit has made important contributions to a better understanding of atherosclerosis.

ERIK STROMGREN, professor of psychiatry at Aarhus University in Denmark and medical director of the State Mental Hospital at Risskov, will participate in the third International Seminars on Mental Health starting 23 April under sponsorship of the Postgraduate Center for Psychotherapy, 218 E. 70 St., New York. He will give lectures on 23 April, 3 May, and 6 May.

Six representatives of Spain's Junta de Energia Nuclear, Spanish counterpart of the U.S. Atomic Energy Commission, are starting a 3-month study of a design for a 32,000 kilowatt nuclear power plant at the General Electric Atomic Power Equipment Department. The visitors, who are among Spain's top nuclear experts, include:

FEDERICO GODED, leader of the group and head of the atomic section of General Electric Espanol; LUIS PALACIOS, a member of the Junta reactor design group; FRANCISCO BOSCH, head of a nuclear group in the Hidroelectrica Espanola power company and editor of a nuclear magazine entitled *Cenusa;* JOSE FITE, a physicist in the Junta; JOSE URQUIA, a member of Instituto Nacional de Industry nuclear section; ANTONIO OSUNA, member of Technatom, a nuclear consulting group.

CLARK T. RANDT, associate professor of neurology in the department of medicine, Western Reserve University, and director of the division of neurology, University Hospitals, Cleveland, Ohio, has been appointed scientist for space medical research in the office of research grants and contracts at headquarters, National Aeronautics and Space Administration, Washington, D.C.

Sir FRANCIS WALSHE, outstanding British neurologist, will visit the medical schools at the University of Washington (St. Louis), the University of Cincinnati, and the University of California (San Francisco) in late April and early May. At the University of Washington he will give the Bishop Lecture. He will participate in an University Extension Division Course devoted to "Neurology of the Cerebral Cortex and Its Related Structures" at the University of California, and he will address the San Francisco Neurological Society on "Mind in Relation to the Brain." Before leaving this country he will also visit Johns Hopkins University School of Medicine and the National Institute of Neurological Disease and Blindness in Bethesda, Md.

MARTIN LINDAUER, outstanding specialist on the behavior of bees of the University of Munich, Germany, delivered the three Prather lectures in biology at Harvard University during the first part of April. His subject was "Forms of Communication in the Social Bees."

Scientific visitors to the United States from Australia are as follows:

T.M. PALMER, senior research officer, Commonwealth Scientific and Industrial Research Organization, National Standards Laboratory, Sydney, arrived on 2 April and will leave the country on 9 May. His itinerary includes California, Colorado, Illinois, the District of Columbia, Pennsylvania, New York, and Massachusetts.

S. M. BRISBANE, senior research

officer, Commonwealth Scientific and Industrial Research Organization, Cement and Ceramics Section, Division of Industrial Chemistry, Melbourne, arrived on 15 April and will leave on 22 May. He will visit California, Illinois, Ohio, Pennsylvania, and New York.

ROBERT F. LOEB, chairman of the department of medicine at the College of Physicians and Surgeons, Columbia University, will retire on 30 June. He will also give up his post as director of medical service at Presbyterian Hospital. Loeb, who joined the university in 1921, will remain as Bard Professor of medicine for another year while on sabbatical leave. His research work led to the successful treatment of Addison's disease and contributed to the knowledge of the metabolism of sodium and potassium.

DANIEL A. BUSCH, consulting petroleum geologist of Tulsa, Okla., has been named the 1959 winner of the George C. Matson Award of the American Association of Petroleum Geologists for his paper "Prospective for Stratigraphic Traps." The award was presented during the association's annual meeting in Dallas, Tex.

KARL HARPUDER, assistant clinical professor of medicine at Columbia University College of Physicians and Surgeons, has been serving this month as the second Louis J. Horowitz visiting professor in the department of physical medicine and rehabilitation at New York University–Bellevue Medical Center.

DONALD P. ECKMAN, professor of mechanical engineering at Case Institute of Technology, has been presented the Annual Award of the American Society of Mechanical Engineers for outstanding work in the field of instrumentation.

ALBERT LEVAN, geneticist at the University of Lund, Sweden, is at the University of Texas to continue cancer research he began in 1957 with John J. Biesele, zoologist at Texas. The two men are conducting the major part of their investigations at the university's M.D. Anderson Hospital and Tumor Institute in Houston.

ERNEST T. S. WALTON, noted Irish scientist and Nobel Prize winner, inaugurated the annual Glover Memorial lectureship in the natural sciences at Dickinson College, Carlisle, Pa., on 17 April. The lecture is named for John Glover, English inventor of the "Glover Tower" process for making sulfuric acid. Walton, a pioneer in nuclear research and a member of Ireland's Atomic Energy Commission, is chairman of the School of Cosmic Physics, Dublin, and a member of the faculty of Trinity College, University of Dublin.

L. ESSEN, senior principal scientific officer at the National Physical Laboratory, England, has received the £500 Wolfe Award. The award is the first of 10 annual awards to be made to the research worker who is considered by the Department of Scientific and Industrial Research, London, to have made an outstanding contribution to the research work of the department during the previous year.

CARL E. SCHWOB has retired as special consultant to the chief engineer on the water pollution control program of the Public Health Service, where he has served since 1955. From 1945 to 1955 he was chief of the Public Health Service Division of Water Pollution Control. In 1948 he helped to shape bipartisan legislation on water pollution and subsequently directed the program which laid a foundation for the abatement of pollution of this country's water resources. He received the Nash Conservation Award for this work in 1953, and in 1955 he was presented the Arthur Sidney Bedell Award of the Federal Sewage and Industrial Wastes Association.

EDMOND C. BUCKLEY, former chief of the Instrument Research Division of the National Aeronautics and Space Administration's Langley Research Center, has been appointed assistant director for space flight operations at NASA headquarters in Washington, D.C.

AGNES B. RUSSFIELD, assistant pathologist on leave from Massachusetts General Hospital, has joined Bio-Research Institute, Inc., and Bio-Research Consultants, Inc., in Cambridge, Mass., as an associate in pathology.

GEORGE B. KOELLE, dean of the University of Pennsylvania Graduate School of Medicine and chairman of its department of physiology and pharmacology, has been named chairman of the department of pharmacology of the university's School of Medicine, effective 1 July. He will succeed CARL F. SCHMIDT, who will become emeritus professor of pharmacology when he retires as chairman, a post he has held for 28 years.

EDWARD L. BORTZ, leader in geriatrics and former president of the American Medical Association who is now chief of the medical service at the Lankenau Hospital, Philadelphia, has been named chairman of the 1960 National Health Forum. The forum, an annual national conference, is sponsored by the National Health Council on behalf of its more than 60 member agencies. The 1960 Forum will be held in Miami Beach, Fla., during the week of 13 March, with "Health of Older People" as its theme.

MICHAEL KASHA, professor of physical chemistry at Florida State University, has been appointed head of the university's department of chemistry. He succeeds KARL DITTMER, who has been appointed director of the Petroleum Research Fund. Kasha will give the Reilly lectures at the University of Notre Dame in May, and will serve as visiting professor of physical chemistry at Harvard University during the academic year 1959–60.

HOWARD H. AIKEN, director of Harvard University's Computation Laboratory, has been elected honorary chairman of the International Conference on Information Processing. The conference, sponsored by UNESCO, will be held in Paris, 13–23 June.

Recent Deaths

FLORENCE L. GOODENOUGH, Lakeland, Fla.; 72; professor emeritus in the Institute of Child Development and Welfare at the University of Minnesota; contributed to research in developmental psychology; 4 Apr.

JOSEPH A. GRAND, Washington, D.C.; 43; chemist in the physical and inorganic branch of the Chemistry Division of the Naval Research Laboratory, where he had been employed since 1941; 2 Apr.

WALTER H. MOURSUND, Houston, Tex.; 74; dean emeritus of the Baylor University College of Medicine; had been dean there for 30 years; wrote *The History of Baylor University College of Medicine—1900–53,* after his retirement in 1953; 3 Apr.

CLARENCE R. O'CROWLEY, Newark, N.J.; urologist and genito-urinary surgeon; had been assistant professor of urology at the University of Pennsylvania's Graduate School of Medicine for 25 years; past president of the American Urological Association and of the American Association of Genito-Urinary Surgeons; 28 Mar.

EMORY C. UNNEWEHR, Athens, Ala.; 73; chairman of the division of mathematics and science at Athens College since 1952; professor of physics at Baldwin–Wallace College, Berea, Ohio, 1919-52; 11 Feb.

Book Reviews

The Origin of Species by Charles Darwin. A variorum text. Morse Peckham, Ed. University of Pennsylvania Press, Philadelphia, 1959. Illus. $15.

Forerunners of Darwin. Bentley Glass, Ed. Johns Hopkins Press, Baltimore, 1959. viii + 471 pp. Illus. $6.50.

The Autobiography of Charles Darwin 1809–1882. Nora Barlow, Ed. Harcourt, Brace. New York, 1959. 263 pp. Plates. $4.50.

The three books listed here are all equally important in this year of the Darwin centennial. One misses only the recognition of Alfred Russel Wallace to make the survey complete. Heading the list is the first variorum edition of the *Origin* to be produced. The second study treats extensively of certain of Darwin's known precursors, with intricacy and admirable scholarly detail, while the third gives, in a more unexpurgated form than has been previously available, Darwin's own account of himself.

It has taken the lapse of a full century to produce a variorum edition of *The Origin of Species*—this, in spite of innumerable changes in the text of the various editions, and in spite of the fact that a single volume containing the variant texts would have been an invaluable tool to the historian of science. At last such a book has been prepared, by Morse Peckham, an authority on Victorian literature and a keen student of Darwin.

The work covers all the changes in the six texts published between 1859 and 1872. In addition, Peckham has written a most informative introduction, replete with new information about the various editions and the history of their publication. The editor has searched out the publishers' actual records and has reproduced them; he has given careful descriptions of the several editions, and he has included photographs of the various bindings. He has done everything that a work of this kind demands, and he has done it with professional skill and exacting thoroughness. The volume should be of service to every student of Victorian literature in the country, and to every biologist and historian who is concerned with the development of Darwin's thought.

The scope of the changes Darwin introduced into the several editions is not only a mark of his restless anxiety about the volume but also an index of the forces that played upon his own thinking. As Peckham points out, it is difficult to find any library which possesses a run of all the authentic editions. Yet without the variant editions, or this variorum substitute, one cannot speak with authority about what Darwin said in the *Origin* at a particular time.

This work will become a researcher's classic and delight. Not content with his accomplishment, however, Peckham is already eager to extend his studies among Darwin's contemporaries and hopes to delve more deeply into the sources of Darwin's thought. The labor expended upon this volume is an index of his devotion to the subject.

Forerunners of Darwin begins with three excellent, individual papers—one by Francis Haber, "Fossils and early cosmology"; the other two by Bentley Glass, "The germination of the idea of biological species" and "Maupertuis, pioneer of genetics and evolution." In the latter paper Glass develops at length, and convincingly, Maupertuis' role as an early evolutionist and geneticist. It is the finest paper in English upon Maupertuis' role in French biological thought. Bentley Glass' expert knowledge of genetics has enabled him to bring out fully the surprising modernity of Maupertuis' thinking.

On the other hand, I would differ slightly with Glass about what he terms the fantasies of de Maillet or Buffon. The works of these gentlemen had wide distribution and profound effects upon human thinking. They, like Maupertuis, had their insights as well as their follies. There is honor enough for all, and the years devour men's writings quickly—almost as quickly as they devour the men themselves. This trickle of evolutionary thought that passes thinly across the border of the 19th century is the product of several, if not of many, minds. We shall do well to speak gently of these men, in the hope that our own fantasies may be spoken of with like gentleness two centuries farther on.

The volume contains a wealth of other material. It is, in fact, a very difficult book to review in a short space. The subject matter, although primarily concerned with evolution, is diverse, many-sided, and exceedingly rich. Lester Crocker writes upon Diderot; Jane Oppenheimer pursues "An embryological enigma in The Origin of Species"; Oswei Temkin has produced a much-needed paper, "The idea of descent in post romantic German biology"; and Charles Gillispie devotes a searching paper to Lamarck's ideas.

The richest ore of all lies in Arthur Lovejoy's collected papers upon evolutionary subjects, which are scattered through the volume. Every student of the history of ideas will be overjoyed to find that these precious papers, so long buried in a diverse range of journals, have now been rescued and placed within the compass of a single book. Lovejoy on Buffon, Lovejoy on Chambers, Lovejoy on Kant and Schopenhauer, Lovejoy on Herder—all are as fertile and suggestive as they were when they were first published. The fact that the history of ideas and of science is now a subject of growing academic interest in America we owe to the pioneer efforts of Lovejoy, among others. The History of Ideas Club at Johns Hopkins University deserves public thanks for its part in recognizing the permanent value of these papers and in helping to insure their preservation in lasting form.

The new edition of Darwin's autobiography, edited by Nora Barlow, his granddaughter, is the first complete and unexpurgated edition of that document, some parts of which had been suppressed upon its first publication out of deference to people then living. Even at the time of Darwin's death emotions still ran high over the religious storm the *Origin* had evoked. This storm was reflected in family counsels and in divided loyalty, on the part of the children, between their father's science and their mother's religion. Nora Barlow has incorporated, in this edition, an appendix treating of the Darwin-Butler controversy, along with various other family memorabilia.

Reading the volume after the lapse of years, one finds oneself touched anew by its simplicity and pleasant informality. The effect is one of bringing the reader into almost conversational reach of the great scientist. "I have attempted to write," Darwin himself informs us, "as if I were a dead man in another world looking back at my own life. Nor have I found this difficult for life is nearly over with me. I have taken no pains about my style of writing." There emerges in the *Autobiography,* for just this reason, something of that flowing, effortless style which makes *A Naturalist's Voyage Around the World* so at-

tractive to us still. Charles Darwin was not without literary sensitivity, despite his complaints about his own stylistic awkwardness and despite his sprawling, leaping, cryptic condensations when the creative ferment was working in him too rapidly for him to control his sentences.

The expurgated material is not startling by modern standards, but it does help to round out our picture of the man and his time. His original theism apparently ebbed with the years, until he became a total agnostic. His lingering Lamarckian conceptions of inheritance led him to comment that the inculcation of religious beliefs in children might cause them to inherit a belief in God. As a sensitive and considerate man, it is evident that the struggle and suffering observable in the natural world offended Darwin's moral sensibilities and led him ever further along the pathway of doubt. It is obvious that he suffered, as did many intelligent Victorians, including Wallace and Lyell, from the great and painful reorientation in human thinking to which he was, at the same time, a leading contributor.

Nevertheless, what was in some ways a sad life intellectually is illumined by Darwin's deep affection for his family, his winning whimsicality, and his genuine devotion to science. There is something a little wistful, a little fey, about his devotion to the lower organisms—almost as though he would have liked to start the whole evolutionary process over again down a different path. "It has always pleased me to exalt plants in the scale of organised beings," he wrote of his botanical experiments, just as he sometimes dwelt upon the intelligence of his earthworms. Yet if men and human cruelty sometimes offended him, no man ever left a more moving tribute to his wife. Written at the end of a letter of hers which he had obviously treasured, is the following: "When I am dead, know that many times I have kissed and cryed over this. C.D."

Into the modern world of doubt and atoms, into the world which has slain its millions in two great, fanatic wars and which now hovers on the brink of a third —a world which has devoted itself to the principles of struggle and made this tired, disillusioned man the spokesman of its philosophy, come these words out of the past. Do they ring strangely in our ears? If so, it will be a measure of how far out of humanity we have grown, and of why Charles Darwin turned to the observation of plants and earthworms in his last years, and of why it pleased him, in his own words, "to exalt plants."

LOREN EISELEY
Department of Anthropology, University of Pennsylvania

Biological Sciences

Living Resources of the Sea. Opportunities for research and expansion. A Conservation Foundation study. Lionel A. Walford. Ronald Press, New York, 1958. xv + 321 pp. Illus. $6.

Marine science until recently was a rather academic discipline, regarded with some tolerance as a sort of hobby with no particular application, pursued by zealots—often bearded. Among the marine sciences, biology was considered perhaps the least practical.

Yet, rather suddenly, the exploding world population and the much less rapid expansion of food supplies have caused people to look to the sea as a possible source of food. In recent years there has been a spate of articles and books on the general theme that the sea is an inexhaustible supply of material and food. The approach of many has been starry-eyed—feed the starving millions with plankton, or raise *Chlorella* to relieve famine in India. "Let 'em eat plankton" might serve as a paraphrase of the general theme.

In contrast, Walford's book takes a hard look, appraising the state of marine science today, particularly marine biology. He raises many questions and answers them to the best of modern knowledge. What do we actually know about the sea, about its plants and animals? How are the resources of the sea now used? How can use be expanded? What do we need for further expansion? What lines should further research and development take? Yet, along with the sometimes brutally frank exposé of current ignorance, there is also the plan of a practical man who knows what has been done and what needs to be done.

Walford is eminently qualified to handle such problems. For many years he was head of all marine biological research for the U.S. Fish and Wildlife Service. He serves on many commissions and committees of international scope for evaluation and study of marine problems and has been chairman of the research committee of the International Commission for the Northwest Atlantic Fisheries.

The book details the strength of our knowledge of marine resources where there is strength but does not hesitate to reveal the weaknesses. The two great shortages—of money and of trained manpower—are mentioned again and again. The sea is no less mysterious in some of its aspects than is outer space, but the amount of time and money going into study of the sea is a minute fraction of that spent on space research.

Although Walford himself is a biologist, he does not neglect the technological and even sociological aspects of the problem. Proper development of a new fishery involves biological research on the animals to be exploited. It also involves engineering research into sorts of gear to be used for their capture, design of new boats or adaptations of old ones, economics of financing the fishery, problems of distribution, and—not least—the sociological problem of convincing people that they should eat an unfamiliar food. Here the strength of this book becomes evident, for each of these problems is taken realistically in turn, and the approach is neither optimistic nor pessimistic. Manpower, money, and time are the ingredients which can solve these problems.

The construction of the book is logical. There are two major sections—one, the definition of the problem; the other, a survey of the known resources. The many maps with descriptive captions actually written into the chapters as an integral part of the text are a unique feature.

One might wish that some of the maps were not so detailed and that more consideration had been given to the problems of printing, but in general they make their points. This is not a textbook and does not need full documentation, but the documentation is unfortunately uneven and often difficult to follow. The index leaves much to be desired.

Nonetheless, here are the facts presented—that the sea is grossly underexploited; that expansion of utilization of marine products along the lines we are presently following can probably only double production; that great areas of the sea and significant numbers of its animals are relatively unknown. Current work is directed toward learning more about known factors rather than exploring the unknown. Unless we redirect the research forces we now employ and create vast new ones, man may discover, when he is actually driven to the sea for a major part of his food, that he will be unable to find it.

JOHN P. WISE
U.S. Fish and Wildlife Service, Woods Hole, Massachusetts

Electronic Apparatus for Biological Research. P. E. K. Donaldson and others. Academic Press, New York; Butterworths, London, 1958. xii + 718 pp. Illus. $20.

Biophysicists are frequently asked to name a single textbook or monograph from which a biologist not familiar with advanced electronics and having only rudimentary physics and mathematics at his disposal can learn enough electronics

and instrumentation theory and practice to enable him to build, operate, and understand such electronic instrumentation as is necessary for his research. This book is probably the best single answer available to the demand for a do-it-yourself guide to biophysical instrumentation. In addition, it is, for the expert, a fine compendium of know-how and references, and it contains succinct résumés of specialized techniques and mathematical developments of basic electrical and electronic theory at a level just sophisticated enough to take care of most needs without requiring the use of advanced mathematics.

The American reader will find three substantial shortcomings in the book, only one of which could possibly be charged against the author: it is written in British, not in American, English; it is too expensive for use as a textbook or as a book to be bought by the neophyte researcher for his personal bookshelf; and it stops 3 to 5 years back in several areas where electronic technology has been dashing forward.

The language problem is not trivial, for electronic jargon *is* substantially different in England and the United States, and a term often has very different meanings in the two countries. Both "static" and "dynamic" transducers, for example, are special types of "active" or "passive" transducers in our usage. Components and circuits have different names, for example, "tagboards" for "tiestrips," "concertina phase splitter" for "split-load phase inverter," "brimistors" for "surgistors," and so forth. These differences seem merely amusing when we understand them, but they are highly confusing when we do not. In addition, examples taken from commercial components are not always applicable to American products, nor is there always an equivalent product.

The neglected, recently-developed areas are particularly those having to do with solid-state devices and the logical circuitry and control-system devices which have arisen out of electronic computer advances and military-industrial control instrumentation. There is a last-minute chapter on transistors which is sound and pertinent, but it stops substantially behind the present state of the art. Masers, nuclear resonance and molecular resonance equipment, magnetic amplifiers, precision function potentiometers, core memories, storage tubes, modulation codes—none of these is more than barely mentioned. Printed circuits and modular construction have been severely neglected. Workhorse computer elements that are entering most up-to-date biological laboratories are conspicuously scarce. Hybrid vibrator-stabilized amplifiers, precision integrators and differentiators, adders, multipliers, rooters, curve tracers, digital-analog converters, direct digital read-outs, and print-outs should at least be mentioned.

Pointing out these shortcomings is, however, in effect praising the book with faint damns. The 280-page section on "Theory" is a splendid introduction or refresher on electronic theory. The 50-page section devoted to "Practice" (components and laboratory procedure) is good but differs substantially from American standards. The 252-page section on "Transducers, electrodes and indicators" covers its chosen material well but falls short of ideal choice of subject matter. Its treatment of microelectrode techniques is outstanding. The material on light sources, temperature and humidity control, and strain-gage transducers includes much material not readily available elsewhere. A final 126-page section on "Complete apparatus" discusses power supplies, bioamplifiers, some recording and timing devices, and it has an unusually appropriate section on interference control. The short chapters on trouble shooting and instrument design are too abbreviated to be of much use.

Over-all the book is undoubtedly the best and most complete source of information on electrical instrumentation currently available to the experimental biologist.

OTTO H. SCHMITT
University of Minnesota

Encyclopaedia Zoologica Illustrated in Colours. vol. 2. "Pisces" by Ichiro Tomiyama and Tokiharu Abe. "Prochordata" by Takashi Tokioka. Hokuryukan, Tokyo, Japan, 1958. 478 pp. Illus. $25.

The first volume of this popular series includes the mammals, birds, amphibians, and reptiles of Japan. Volume 2 illustrates the fishes and prochordates. Volume 2 is divided into three sections, of which the first two were written by Tomiyama and Abe. The first section covers 912 species of marine fishes, illustrated in color; for each, the common and scientific names, a brief description, maximum size, and distribution, are given; for fish of economic value, the texture of the flesh is given also. The second section, on aquarium fishes, covers 108 species, illustrated in color, and gives information of importance to an aquariist. The section on the Prochordata, by Tokioka, contains illustrations, in color and in black and white, of 135 species, and for each one the scientific and common names, a brief description, and size and distribution are given.

The fishes are carefully illustrated by the following artists: Yoshikichi Makino, Ketsunori Tateishi, Mitsuo Shirao, Tadanao Hayabuse, and Masaru Goto. The colored photographs were taken under the supervision of Tadashi Tomura.

This gorgeously illustrated volume was intended to be a popular account of the fishes and "prochordates" of Japan, and without doubt the authors have succeeded in fulfilling this intention. In general, this is a basically accurate work, with only a few instances of careless spelling of scientific names. We disagree, for only a small number of the species, with the scientific nomenclature used for the marine and aquarium fishes. The authors should be proud of this book.

LEONARD P. SCHULTZ
ROBERT H. KANAZAWA
Division of Fishes,
U.S. National Museum

Heredity and Evolution in Human Populations. L. C. Dunn. Harvard University Press, Cambridge, Mass., 1959. 157 pp. $3.50.

This, the first of the "Harvard Books in Biology," sets a nice tone for a series of books designed for laymen. In his interesting preface, Dunn acknowledges that his writing is not colorful, saying that this is as it should be, that he prefers an accurate statement to a fine phrase. Having set the stage thus, the author proceeds to the essentials of genetics and evolutionary principles. The implications of the sickle-cell trait are well presented. The variation in the distribution of the blood-group genes is posed as a problem in selection that is yet to be solved. Dunn's study of the Jewish community in Rome is retold. Restraint marks the discussion of methods of consciously altering human gene frequencies. The only objectionable statement made is the one at the bottom of page 88 that implies that *gene* frequencies can be altered by prohibiting the marriage of cousins; in truth, only genotype (and phenotype) frequencies are affected by the mating system used.

Since this is the first of a new series, a suggestion may be in order regarding style. Dunn's book contains no bibliographic citations whatever. The thinking behind this is obvious. But is it not possible that the publishers have underestimated "the layman"? At this moment, grocery stores all over the country have on sale cartons of Coca-Cola in which there is a little leaflet discussing nutritional matters: the effect of sugar on teeth, the nutritional identity of "natural" and artificial sugar, and so forth.

The write-up concludes with some half dozen citations of original research papers, carefully chosen for quality and relevance. Now all this, you may say, is just "window dressing." How many food purchasers will ever check the references? Few indeed; but that is not the point. The fact that the men from Madison Avenue should use this gimmick implies a greater sophistication on the part of the soft-drink buyer than the editors of a university press will grant to the readers of Dunn's book, which is hardly likely ever to descend to a display rack beside the grocery checking counter. A book of this sort should not have an exhaustive listing of its sources, but a representative sample of the better reviews, monographs, and selected original papers would surely increase its impact on the class of reader to which its content appeals.

GARRETT HARDIN
Department of Biological Sciences, University of California, Santa Barbara

Anatomie de Latimeria Chalumnae. vol. 1, *Squelette, Muscles et Formations de soutien.* 122 pp. (text) + 80 pp. (plates). J. Millot and J. Anthony. Publié avec le concours de L'Institut de Recherche Scientifique de Madagascar, Tananarive, par les Éditions du centre National de la Recherche Scientifique, Paris, 1958.

This sumptuous volume on the skeleton and musculature of the coelacanth *Latimeria chalumnae* is the first of a series by Millot and Anthony on the anatomy of this unique and venerable fish. Ten adult and subadult specimens, including three females, are available for this investigation, which is being carried out at the laboratory of comparative anatomy of the Muséum National d'Histoire Naturelle, Paris.

The details of the skeleton, which are of particular interest to paleontologists, confirm in a striking manner the amazing conservation of this system, which, in most respects, has remained unchanged in the coelacanths since the late Devonian. The partly cartilaginous braincase, divided into separate ethmosphenoid and otico-occipital segments, is nearly identical with the completely ossified neurocranium of the Devonian coelacanths. There is limited motion between the segments, which are held together by ligaments, and ventrally by powerful subcephalic muscles. These muscles work in opposition to the coracomandibularis muscles which elevate the anterior segment through the intervention of the palatoquadrate.

There is also a close and unquestionably significant resemblance to the well ossified rhipidistian braincase, but with two important modifications. First, the ethmosphenoid moiety in *Latimeria* contains a large median rostral cavity which has three openings on each side to the exterior and contains an organ of unknown function. It now seems probable that the cavity was present in all fossil coelacanths but was absent in the rhipidistians. There is also a median nasal sinus, regarded by the authors as a vestige of an embryonic internasal cavity. Second, the intracranial anticulation in the coelacanths is modified by the development of an antotic process, followed, in the Carboniferous, by the loss of the basipterygold process. Although it is not specifically stated, it appears that the maxillary and mandibular branches of the trigeminus in *Latimeria* emerge at the intracranial fissure, instead of within the otico-occipital segment as in the rhipidistians. Also, the foramen for the profundus nerve is in front of the antotic process. These changes are associated with a basic difference in the jaw mechanism in coelacanths and rhipidistians, but as Romer pointed out, they do not necessarily mean that there is a fundamental difference in the location of the intracranial joint in the two groups.

Tertiary coelacanths are unknown, and the Mesozoic ancestry of *Latimeria* cannot at present be ascertained. The dermal skull pattern, particularly in the snout region, is suggestive of certain Triassic genera rather than the known Jurassic or Cretaceous forms. The reduction in the ossification of the cheek elements and in the supraorbital series also occurred in several Triassic genera, but this may well be a case of parallelism.

The anatomy of the visceral skeleton elucidates a number of points which have not been clarified in the fossil forms. The hyomandibular, previously known in one Devonian genus, has a large canal for the hyomandibular vein and the mandibular and hyoid branches of the facial nerve. This was presumably the situation in most rhipidistians, although in one (*Eusthenopteron*) the hyoid branch was wrapped around the lateral surface of the hyomandibular. The peculiar articulation of the symplectic with the mandible well behind the typical quadrate-articular articulation is known only in *Latimeria,* but it may have existed in the extinct genera as well. There are five branchial arches, presumably the number in the rhipidistians, covered, as in *Eusthenopteron,* with dental plates.

The notochord is a fibroelastic tube, extending anteriorly through the notochordal canal of the otico-occipital segment to the posterior face of the basisphenoid. Cartilaginous "basidorsals" and "basiventrals" are situated above and below the notochord. The neural spines only are ossified. Ribs are absent. The notochord was undoubtedly persistent in all coelacanths back to the Devonian, and there is no suggestion of a perichordal chondrification or ossification. By contrast, all known rhipidistians had perichordal ossification, foreshadowing the condition in tetrapods.

The fins are typical in all respects, with the characteristic "lobed" condition in the paired appendages, as well as in the second dorsal and the anal fins. One point of particular interest is that the ball-and-socket joint between the girdles and their corresponding fin skeleton is the opposite of the rhipidistian-tetrapod condition. In *Latimeria,* the head is on the endoskeleton of the girdle, and the socket is on the proximal element of the fin skeleton. The exoskeletal part of the girdle is not attached to the skull, and the supracleithrum is absent. The internal skeleton of the paired fins differs mainly from that of the rhipidistians in the reduction of the proximal preaxial radials. The pectoral fin has well-differentiated adductor and abductor muscles and deeper, numerous pronators and supinators which enable the fin to rotate about 180 degrees. The pelvic musculature has a similar but somewhat less complicated arrangement. Consideration of the implications of this pattern in relation to the transition from fin to limb will be greatly aided by a description of the innervation, which will presumably be included in the next volume.

In a rather involved concluding statement, Millot and Anthony discuss the possible meaning of certain features found in *Latimeria.* They agree with Romer (for crossopterygians in general) that the persistent notochord and the subdivided braincase are neotenic characters, and they add to these the high proportion of cartilage in the braincase of the post-Devonian coelacanths. In seeking an explanation for the remarkably small brain volume of *Latimeria* in relation to the volume of the cranial cavity (about 1/100) and for the greatly extended stalk of the pituitary, they apparently reject the possibility of allometric growth (for which there is no present evidence) in favor of this being the primitive condition. They attribute the large size of the pedunculated fins to hypertely, related to an increase in body size. In my opinion, a satisfactory explanation for the amazingly small brain of *Latimeria* has not yet been found, while the size of the pedunculated fins may be related both to body size and to function.

There are many details in the skeleton and musculature which cannot be considered here that are of interest from

both phylogenetic and functional points of view. As is inevitable with any anatomical description which follows the organ system plan rather than the regional one, it is not now possible to obtain a complete picture of any part of *Latimeria*. The authors have included some pertinent remarks about blood vessels, nerves, and the brain; but for most of these details we must await the succeeding volumes. They have greatly enhanced the usefulness of the text by making frequent comparisons with the fossil coelacanths and with the rhipidistians.

The illustrations, including x-rays, photographs, and drawings, are numerous and excellent. There are a few unfortunate omissions, and some of the figures have no labels or are inadequately labeled. A lateral view of the complete skull plus visceral arches is, surprisingly, absent, although it would be very helpful. Additional drawings of the visceral skeleton, including the basibranchial elements, would be very desirable.

This volume, and the others to come, represent one of the most important additions to the literature of vertebrate morphology in many decades. The authors are to be congratulated for the thorough manner in which the investigation is being carried out.

BOBB SCHAEFFER
Department of Geology and Paleontology,
American Museum of Natural History

Records of the American-Australian Scientific Expedition to Arnhem Land. vol. 3, *Botany and Plant Ecology*. R. L. Specht and C. P. Mountford, Eds. Melbourne University Press, Melbourne, Australia, 1958 (order from Cambridge University Press, New York). xv + 521 pp. Illus. $19.50.

Arnhem Land, an aboriginal reserve on the northern coast of Australia, was the site in 1948, of a joint American-Australian scientific expedition. Seven months were spent by the participants at selected stations on the mainland and on a large offshore island; during this time, nearly 45,000 specimens of plants and animals were collected, as well as vast quantities of data and specimens for ethnologic and anthropologic study.

R. L. Specht, one of the coeditors of this second volume of the four planned to report the results of the expedition, served as the botanist and ecologist on the venture. He is also the author or coauthor of the sections of the report concerned with the identity of the higher plants and their ecological and phytogeographical interrelationships; the final section, on the ethnobotany of the region, is also written by Specht. Various specialists have contributed chapters on the fresh-water algae, on the Characeae, the marine algae, the Basidiomycetes (with the exception of the Agaricaceae, which are treated in a separate section), the lichens, the bryophytes, and the pteridophytes. A number of new taxa are described in several of these groups, especially among the fresh-water algae.

This is a scholarly work which does not purport to be entertaining reading; it is a technical report of a well-executed scientific study. As such, it is an exceedingly valuable addition to the botanical literature for that part of the world. The two chapters on climate, soils, plant ecology, and the geographical relationships of the flora should be especially useful.

RICHARD S. COWAN
U.S. National Museum,
Smithsonian Institution

The Tarantula. William J. Baerg. University of Kansas Press, Lawrence, 1958. 88 pp. Illus. $3.

"To anyone who has learned to know this spider, it is as handsome as a goldfinch, and fully as interesting." Though many an open-minded biologist might understandably take issue with the first assertion, after reading W. J. Baerg's lively and authoritative account of the tarantula, he could not help but subscribe, perhaps with sudden surprise, to the second. Tarantulas are indeed shown to be interesting animals in this small but factually saturated work.

"Tarantula," technically a misnomer, popularly refers to certain reputedly primitive and chiefly tropical spiders of the suborder Orthognatha (or Mygalomorphae). For the uninitiated they are too often *the* spidery horrors par excellence; their gargantuan proportions, often hairy massive bodies, huge projecting fangs, and unlikely turret of tiny gleaming eyes have somehow gained them an often unshakably sinister reputation. Their presumed invariably fatal bites, propensity for bullying human beings, and ability to leap fantastic distances, and other macabre characteristics, are investigated, discussed, and usually discounted by the author in his easy conversational and frequently witty style. He defends tarantulas vigorously and might well have asked, as did one eminent araneologist, why people regard tarantulas' hairy bodies and long, thin legs with frank horror when these same characteristics in Russian wolfhounds are quite acceptable if not desirable.

The book is entirely concerned with the ethology of these spiders, not with their distribution, classification, or identification. Drawing upon 35 years of experience with them, Baerg outlines, probably for the first time, a complete life history, from birth to death, of each sex—no small task when one considers that these chelicerate Methuselahs may live for 20 years or even longer. He provides a first-hand account of their mating habits, describes their seasonal activities, and deals briefly with their natural enemies—chiefly pompilid wasps.

There is a most entertaining and enlightening—though perhaps for some readers a chilling—description of Baerg's quests for the great spiders and their lore in Mexico, Central America, and the Caribbean area. Baerg concludes with a short though informative treatment of tarantula venom and its effects upon laboratory animals and even upon himself. Injection of the venom may be painful, he says, but in the case of the majority of species, the venom seems essentially harmless to man.

The little book was obviously written affectionately and from the vantage points of dedication and much experience. It is good reading, but in addition it is a valuable scientific contribution. In closing Baerg writes: "In fact, for anybody who has the good fortune of having one or more of them living in the backyard, as several of my colleagues have, tarantulas are good neighbors. . . . They stay long enough for one to become much attached to them." In 35 years of close association the author has clearly become attached to them as well as expertly informed about them.

R. E. CRABILL, JR.
U.S. National Museum,
Smithsonian Institution

The Submicroscopic Organization and Function of Nerve Cells. *Experimental Cell Research,* suppl. 5. Academic Press, New York, 1958. 644 pp. Illus. Cloth, $14; paper, $12.

Under the auspices of the Venezuelan Institute of Neurology and Brain Research of Caracas, Venezuela, a group of distinguished investigators from Venezuela, the United States, and several other countries reported, at a symposium held 15–22 March 1957, in Caracas, on recent advances in the fine structure and function of nerve cells.

The collected papers in this volume are grouped under five major headings: "The nerve fibers," "The nerve cell membrane," "The neurons," "The synapses," and "The receptors." These symposium papers do not represent an integrated approach to any one topic but are concerned with various problems of both investigative and theoretical interest. Some of the data presented are not

new, having been published, *in toto* or in part, elsewhere. Other papers are literature reviews. Although some of the topics have already received much attention in earlier published works, emphasis has been placed not only on additional new data but—what is perhaps even more important—on attempts to correlate structure and function through the use of a wide variety of experimental techniques. Among the methods employed by the various investigators were x-ray diffraction, electron microscopy, light microscopy, histochemistry, biochemistry, pharmacology, and electrophysiology. In most instances the investigators employed more than one experimental method. This approach has yielded a clearer understanding of the topics under consideration. Moreover, it presents the most recent morphological, biochemical, and physiological data in relation to current thought and research trends in certain areas of cellular neurobiology.

In addition to the papers dealing with nervous structure and function, four studies are included in the collected papers of the symposium which are of peripheral but, nonetheless, current interest. The high level of the papers is punctuated by an amusing addendum to one of the studies.

This book will be of value chiefly to those investigators whose interests lie in similar research areas. It should also be of value to cellular and comparative biologists with adequate backgrounds in the field of neurobiology, but it will not be easy going for the casual reader.

RONALD A. BERGMAN
Department of Anatomy,
Johns Hopkins University

The Biological Way of Thought. Morton Beckner. Columbia University Press, New York, 1959. 200 pp. $6.

The biologist today is a curiously nervous fellow. He is beset by an ever-increasing need for physicochemical techniques and at the same time is alone in the task of reassembling the extracted parts into the living organism. Latter-day mechanists consider biology to be merely a complex extrapolation of physics and chemistry, while the modern heirs to vitalism, the "organismic biologists," vehemently reassert that the whole is greater than the sum of the parts. Reductionism versus emergence is still being argued.

Morton Beckner's book is a useful clarification of the position that biology is a unique and autonomous discipline which requires its own techniques of theory formation despite its use of physicochemical data. To this end, he restates the philosophic basis of organismic biology and examines the qualities of organization, directiveness, and historicity which are attributed to living things alone. In effect, Beckner concludes that in our present state of ignorance the biologist has, perforce, to develop a methodology and a philosophic approach which is far removed from the physical and chemical mechanisms underlying the behavior of biologic material. This is best illustrated in such areas as taxonomy, evolution, and selection theory and genetics, where the New Systematics may be successful in resolving many problems of classification. Of more general interest is the closely reasoned case for the utility of model explanation and the teleological explanation in approximating biologic "truth."

Unfortunately, the working biologist is likely to be overwhelmed by the tortuous terminology used. Furthermore, a more immediate problem confronting the biologist is not the need to rise above the physical sciences but, rather, the need for enough training in physics and chemistry to put the enzymes back into the cells. One must agree in substance with Beckner that the traditional approach of the biochemist will not resolve the question of what is life, but neither will the New Systematics.

ESTELLE R. RAMEY
Department of Physiology,
Georgetown University Medical Center

Mineral Nutrition and the Balance of Life. Frank A. Gilbert. University of Oklahoma Press, Norman, 1957. xv + 350 pp. Illus. $5.95.

The book is a critical review of 1177 books and articles on the mineral elements necessary to life on earth. The following essential elements are discussed: phosphorus, calcium, magnesium, iron, potassium, sulfur, copper, manganese, zinc, iodine, boron, molybdenum, aluminum, silicon, sodium, chlorine, fluorine, arsenic, lead, selenium, and vanadium. Each element is treated separately with respect to its relation to plants and animals, its essentiality, and its occurrence in water, soil, and living tissues. The deficiency areas and deficiency symptoms in plants and animals and the connection of some of these elements with enzymes, vitamins, and hormones are shown. The final chapter deals with the relation of soil and fertilizer to mineral metabolism in plants and animals, with human nutrition, and with national health. This chapter, which consists of only eight pages, is much too short to convey even a most elementary understanding of such complex and difficult subjects.

FRANCIS JOSEPH WEISS
Arlington, Virginia

Die Haustiere Afrikas. Ihre Herkunft, Bedeutung und Aussichten bei der weiteren wirtschaftlichen Erschliessung des Kontinents. Caesar R. Boettger. Fischer, Jena, Germany, 1958. x + 314 pp. DM 31.20.

This remarkable book is probably the most complete, the most up-to-date, and the most critical account in existence of our knowledge of the origin, evolution, and distribution of domestic animals, of their value to man, and their influence on the development of cultural patterns. Although relatively few of the animals under domestication have their origin in Africa, most of the others have been introduced into this continent since prehistoric times, and, therefore, this book deals with almost all of them, even with bees, silk moths, and cochineal insects. The only domestic species not introduced, and therefore not discussed, are the reindeer, the three South and High Asiatic species of cattle—that is, the gayal, banting, and yak—and the South American llama and alpaca.

In contrast to widely prevailing views, it is pointed out that nomadic life is not the precursor of sedentary agricultural culture but that random food gathering, including hunting and fishing, preceded planting, that regular agriculture became possible only after suitable domestic animals had become available, and that the modern nomadic life is a secondary development brought on by the necessity of feeding too many livestock.

It is shown that the dog is the oldest domestic animal, that the pig is next in line, and that it was replaced in the Near East by cattle, sheep and goats. The origin of all these domestic animals is in the fertile crescent of anterior Asia, although later on related subspecies of the same forms were tamed, and frequently crossed, with the original stock in other parts of Asia, as in India, Malaysia, and China.

Whereas most species were domesticated for reasons of utility, cattle and the cat originally were taken on for cultic reasons. The same applies to the jackal in Egypt, which is no longer associated with man.

African origin is accepted for the donkey, cat, ferret, rabbit, pigeon, dove, guinea hen, and some breeds of bees. However, other species were temporarily kept in Egypt, such as the jungle cat (*Felis chaus*) (for cultic reasons), the striped hyena, three species of antelope, the Nile goose (*Alopochen aegyptiacus*), and the African elephant (in North Africa). Some of the introductions from Asia, the distribution of which is more restricted, are the horse, the water buffalo, and the dromedary. The latter is considered to be derived from a wild species different from the wild ancestor of the Asiatic two-humped camel.

The economic value of the introduced species is discussed in detail, and the question is raised whether the development of new domestic stock from the native wild African fauna is possible, and under what conditions.

This book is an indispensable reference book and a standard work for the zoologist, the ethnologist, the prehistorian, and the economist. Its style is condensed and does not make for easy reading. The literature is given in footnotes. There are no illustrations.

ERNST SCHWARZ
Armed Forces Institute of Pathology, Washington, D.C.

Economics and the Social Sciences

Population Growth and Economic Development in Low-Income Countries. A case study of India's prospects. Ansley J. Coale and Edgar M. Hoover. Princeton University Press, Princeton, N.J., 1958. 389 pp. $8.50.

This is the third major study in Asian demography sponsored by the Office of Population Research at Princeton University; the other two are Kingsley Davis' volume, *The Population of India and Pakistan* (1951), which is an indispensable tool for anybody interested in Indian population problems, and Irene Taeuber's study, *The Population of Japan,* which has just appeared.

Contrary to what the title suggests, Coale and Hoover's book is almost exclusively devoted to an examination of the prospects for Indian population growth and the economic implications of different rates of growth over the period 1956 to 1986. Towards the end of the book the results for India are compared and contrasted with prospects in Mexico.

In the absence of reasonably reliable vital statistics, forecasts of population growth in India had hitherto been limited mainly to simple projections of the decennial growth rate shown by recent censuses. The 1951 census commissioner based his discussion of future prospects for population growth and food supply, and his eloquent plea for an active population policy, upon the broad assumption that the Indian population would continue to grow at the annual rate of 1.2 percent at which it grew in the decade 1941 to 1951. The same rate of growth was assumed in the long-term projections given in the second Indian Five-Year Plan. It is one of the great merits of Coale and Hoover's book that it shows the dangerous irrelevance of such mechanical projections.

As a starting point for their projections, the authors had to make independent estimates of the age distribution and the vital rates in 1951. Their method is designed to avoid the distortion arising from the unreliability of age reporting in Indian censuses. Briefly, the method is based on the hypothesis that the level of fertility and over-all growth rates have changed little over the 30 years from 1921 to 1951 and that the structure of the population must therefore approximate closely that of a "stable" population in which the life table is directly given by the age distribution. On this basis, the most likely age distribution, the birth rate, and the age-specific mortality rates for 1951 are determined, and projections (by the component method) are made by 5-year age groups and for 5-year intervals until 1986.

It is assumed that mortality will decline sharply until 1971, at a rate somewhat similar to that at which it has declined in Ceylon. According to detailed estimates by the authors, life expectancy at birth had already increased from around 32 years in 1951 to slightly less than 38 years in 1956. It is assumed that it will increase further, to 50 years by 1976, largely as a result of the eradication of malaria. This assumed trend in mortality is combined with three different assumptions on the course of fertility.

With unchanged fertility, the Indian population would by 1986 be slightly more than double its size in 1956. This projection, based as it is on rather extreme assumptions for both mortality and fertility, may be regarded as the upper limit of the range of conceivable population growth.

At the other extreme, a projection is made on the assumption that fertility rates will decline linearly by 50 percent over the 25 years from 1956 to 1981. This is a tall order, but even so the 1986 population would be 53 percent above that of 1956. Thus, even if there should be a very successful drive to reduce fertility, population would grow at a higher rate than has been observed for any previous period of 30 years.

It is particularly interesting to compare this with the result of the third and last projection, which assumes that the same end result, a 50 percent decline in fertility by 1981, is brought about in the much shorter span of 15 years, beginning in 1966. In this case of a delayed but much sharper decline in fertility, the increase in population from 1956 to 1986 would be 65 percent. In other words, if the beginning of the decline in fertility is delayed, a *more than proportionate* increase in the effectiveness of population control will be necessary in order to keep population down to a given target figure at any future point of time. This is obvious, upon reflection, but it is the kind of obvious truth that needs to be repeated and worked out in dry figures so as to make it clear that postponement in matters of population policy means that far more drastic, painful, and costly measures will have to be taken at a later stage.

The bulk of the volume is devoted to answering the question: "What is the difference in the levels of income per head which would be associated with the high and low fertility trends, respectively?" The reasoning is essentially in terms of the familiar growth model, in which output per head results from assumed values of the savings ratio, the marginal return to investment, and the increase in population. But the authors have refined this simple model in several important and interesting ways.

1) The amount of resources available for purposes other than personal consumption is made to depend upon income per consuming unit rather than upon aggregate income. Hence, under lower fertility a larger share of total output is available for raising output per head.

2) Instead of postulating a marginal rate of investment (or saving), as usually understood, the authors postulate a given share of increments in income to be available for addition to the combined category of public outlays (whether on current or capital account) and private investment. This enables them to make explicit allowance for the fact that the resources that have to be devoted to education and other welfare expenditure depend upon the age composition, which in turn is a function of fertility. With a smaller number of dependents (such as would result from declining fertility), a smaller share of available resources would have to be devoted to welfare expenditure; this would have "a diluted, indirect or delayed effect on output," and more would be available for outlays which "raise aggregate output in a relatively direct and immediate way."

3) Within the category of welfare outlays a further distinction is made between those which are required for the current needs of the existing population and those needed to provide facilities for additional people. For the first category a productive effect of half that of "direct growth" outlays is predicted, and it is assumed that even this reduced effect would be somewhat delayed, by 15 years. The second category of outlays, which becomes the more important as the fertility rate rises, is assumed to have zero growth effect within the horizon of the projections.

4) Finally, it is assumed that the capital-output ratio would increase gradually during the period, from 3.0 to 3.6.

The projections rendered by this model show that on the basis of the low-fertility assumption, income per consumer in 1986 would be around 40 percent higher than the figure based on the

assumption of unchanged fertility. The increases in income in relation to 1956 income are also shown, but the authors are the first to point out that these figures have little significance, if any. They emphatically disclaim any intention of forecasting national income 30 years ahead; they are interested solely in the relative difference between the results under conditions of high and low fertility. In order to test the significance of this differential, the estimates of the parameters are varied within fairly wide limits. While these variations of course give widely differing rates of growth of national income, the relative difference between the high- and low-fertility variants remains remarkably stable, at around 40 percent. This differential would, if anything, be a minimum, since no allowance has been made for the feedback effect of higher consumption improving the vigor and efficiency of the labor force independently of investment or other development outlays. The authors discuss this factor (page 261) but refrain from introducing it explicitly in the model, since any prediction of the extent of this effect would have to be based on pure guesswork.

It would be strange if a couple of mistakes could not be pointed out in a volume which marshals such a vast amount of empirical material. We are told on page 86 that over the last century the proportion of the Indian people engaged primarily in agriculture has increased from about 50 to 70 percent. This is probably due to a misinterpretation of the occupational classification of the 1872 census. It is indeed difficult to imagine what could have been the activities of the "nonagricultural" half of the population a century ago when only 7 to 8 percent of the population were living in towns. On page 116 the Indian agriculturist is said to be "occupied for only about three months in the year, and many of the landless labourers even less than that." Here the authors can perhaps be excused, for vast exaggerations of the amount of rural unemployment abound in Indian economic literature. On page 194, housing is estimated to account for no more than 15 percent of the "monetized" fixed investment. Twice that figure would be nearer the truth. This mistake is of some importance in the further calculations, for the (allegedly) very low share of housing (which has a particularly high capital-output ratio) is cited by the authors in arguments favoring the assumption of a rather low over-all capital-output ratio for India.

However, these are only petty slips in a book which is very comprehensive and full of original and stimulating ideas. No doubt it will prove to be a highly influential book. It does not preach or plead in matters of population policy, but nevertheless—or perhaps therefore—it cannot fail to serve as an eye opener. In fact, it has been serving that purpose since 1956, when a preliminary draft was given wide circulation among Indian economists and demographers.

MOGENS BOSERUP
Twentieth Century Fund Asian Study, New Delhi, India

The Evolution of Culture. The development of civilization to the fall of Rome. Leslie A. White. McGraw-Hill, New York, 1959. xi + 378 pp. Illus. $7.50.

Leslie White, a veteran social anthropologist at the University of Michigan, has set himself the monumental task of writing the social history of man in three volumes. This, the first, has 278 pages on primitive culture and 89 pages on the agricultural revolution and its consequences, carrying the story to the fall of Rome. Volume 2 will be on the fuel revolution and its consequences. Volume 3 will be a review of the current scene and a prediction for the next hundred years.

In volume 1 White expounds the theories that he has been forging over a lifetime: The 19th-century exponents of cultural evolution—Tylor, Morgan, Spencer, and others, who followed close in Darwin's wake—were right; Franz Boas, who, according to White, poisoned a generation of anthropologists against these titans, was dead wrong; and he, Leslie White, alone, unaided, and defiant, has been able to revive, refine, and restate the older concepts in terms of modern science.

He traces the origins of human society from a primate background, calling the acquisition of speech a primate revolution. Following Morgan, he divides social systems into two categories—primitive and civil. Primitive society is based on kinship and lacks classes and property in the modern sense. Civil society arose after the agricultural revolution, and "all civil societies are composed of two major classes, a small, dominant, ruling class and a large subordinate class of slaves, serfs, peasants, or proletariat" (page 219). In primitive society happiness was for everyone; in civil society, only for the privileged few. In primitive society economic organization is a function of social structure; in civil society the reverse is true.

In a review of this length it is impossible to point out details. Some of White's deductions, such as that on the origin of incest, seem original and plausible, but there are also weaknesses. For example, he divorces culture from the individual as completely as some psychologists remove the mind from the nervous system, and he proposes to ignore the biological element in the formation of cultures. If every primitive man cooperated as thoroughly as White maintains, there would have been no biological evolution.

What strikes me most is not the content of the book but the tone—the angry vacuum in which it seems to have been written. He quotes many 20th-century anthropologists, but almost always only to refute them; he has kind words only for Cora DuBois and G. P. Murdoch. Others who are not "Boasites" and who have also been engaged in studying the evolution of culture he ignores completely. Perhaps silence is meant for a compliment. Anyhow, it will be interesting to see what happened in the fuel revolution, and to find out what the future holds for us.

CARLETON S. COON
University Museum, University of Pennsylvania

Motivation. A systematic reinterpretation. Dalbir Bindra. Ronald Press, New York, 1959. vii + 361 pp. Illus. $5.50.

In a field as formless and ill-defined as the psychology of motivation, it would be hard to write a textbook without at the same time introducing categories and principles designed to impose sense and order where these are now lacking, and thus assuming the responsibilities of a monograph. The present book is no exception, and its dual role is acknowledged in its title and subtitle.

The content of the book has to do with the activities of "eating, drinking, approaching, escaping, attacking, exploring, copulating, maternal care of the young, and the like," largely at the infrahuman level. These activities are called "motivational phenomena," and are seen as raising two questions: How are responses patterned into goal-directed action? And what variables determine the latencies, frequencies, amplitudes, and other quantitative properties of the behavior? Bindra believes that no physiological or psychological processes exist that are unique to motivation, and such concepts as motive, drive, need, and incentive are dispensed with or are given secondary status. In their place, to account for patterning, is a concept of reinforcement strongly resembling Skinner's concept, together with a Hebbian emphasis upon the significance of early experience. Quantitative variations in behavior are dealt with as functions of habit strength, sensory cues, level of arousal, and blood chemistry. The ade-

quacy of these principles is tested by applying them to a variety of concrete problems.

It seems doubtful that readers of a different persuasion will be convinced that notions of "drive" and "incentive" are superfluous—their absence is too often felt in this book. Moreover, Bindra's own concepts of "motivational phenomena," "goal direction," "habit strength" (an unfortunate term, since what is meant is not what Hull called by this name but rather something closer to his "reaction potential"), and "arousal" are defined by conventional complexes of symptoms that admittedly lack consistent intercorrelation, and thus suffer from the awkwardness and tentativeness ascribed by Bruner, Goodnow, and Austin (in *A Study of Thinking*) to such disjunctive concepts.

On the other hand, most of the text stays very close to experiment, and here it will be hard to surpass. The carefully detailed and well-documented descriptions of those forms of behavior upon which the author has centered his attention are admirable. The experimental work, which has been chosen carefully for its relevance, is analyzed clearly and economically and is evaluated shrewdly. The frequent suggestions toward further research are uncommonly realistic and stimulating. For these reasons, what is true of few new books in psychology can be said of this one, that one wishes it were twice its present length.

FRANCIS W. IRWIN
Department of Psychology, University of Pennsylvania

Soviet Economic Aid. The new aid and trade policy in underdeveloped countries. Joseph S. Berliner. Published for the Council on Foreign Relations by Praeger, New York, 1958. xv + 232 pp. $4.25.

Why does the Soviet Union render economic aid to underdeveloped countries? How does its effort in this direction compare with that of the West? What is the connection of Soviet aid with trade? What is the balance of economic and political advantage? It is to questions like these that this book provides serious, thoughtful answers. At a time when exaggerated, alarmist nonsense is all too common, Berliner's moderate and well-documented exposition deserves every welcome. Of course, it cannot be wholly up-to-date, but nothing that has occurred since the manuscript was sent to the printer affects the validity of the basic arguments of its author.

It is important to avoid the unbalanced ultra-"political" attitude which is so often met with whenever Soviet activities are the subject of discussion. We hear of "tremendous Soviet aid drives"; the arrival of a group of Soviet technicians is assumed to be evidence in itself of plots and subversion; by some curious logic, a Soviet credit or arms delivery is regarded not merely as an inconvenience to the West (which it often is) but also as a politically immoral act, though no one has yet explained by what moral principle only the West is entitled to grant economic or military aid to third parties.

Berliner shows that there are more sensible ways of looking at these problems. He rightly emphasizes the predominantly political motivation of aid—how could it be otherwise?—but finds such Soviet activities quite logical in the circumstances. "The Soviet leaders may have felt they had little choice but to get into the aid business, if they wanted to exercise continuing influence on the course of events in underdeveloped countries" (page 17). This influence is exercised not so much by direct "cloak-and-dagger" subversive maneuvers, which are relatively rare and do not play a decisive role, as by a more general and more long-term effort to win friends and influence people. The actual scale of Soviet aid has been a small fraction of that of Western aid—smaller than would appear from a straight comparison of the relevant statistics, because the figures usually cited for Soviet (but not Western) aid include commitments to supply goods in future years, and also because almost all Soviet aid consists of interest-bearing credits, while the bulk of Western assistance takes the form of outright grants. When all this is allowed for, the actual annual flow of aid from the Soviet bloc can scarcely amount to more than 3 to 4 percent of that from the West. Nor has the rate at which new credits are granted shown any upward trend since 1956.

Why, then, has the political effect of the aid program been so disproportionately large? Berliner advances some good reasons: novelty, the anti-imperialist traditions of the U.S.S.R., the attractiveness of the Soviet example of rapid transition from backwardness to industrial might, and the alleged lack of "strings" or of irritating controls over the objects on which the money is spent. These and other points receive a careful assessment. Berliner also analyses the causes of the partial Soviet retreat from the extreme autarchy which characterized the late Stalin period—the gradual realization that there are economic as well as political advantages to be gained from having more dealings with the outside world. Yet, as he shows, autarchic tendencies remain, and they tend to obstruct the extension of Soviet ties with non-Soviet countries. Soviet resources are heavily committed to sustaining extremely ambitious programs of internal growth, and it is by no means clear that much larger quantities of capital goods can be made available for export outside the Soviet bloc in the near future, though as Berliner rightly points out, much depends on political decisions about priorities.

There are a few points at which critical remarks seem to be called for. Thus, the treatment given to trade (as distinct from aid) on balance tends to understate the economic advantage of commodity exchange to the Soviet bloc and, therefore, to overemphasize by implication the purely political element in trade policy. Then there are two statistical errors, which operate in opposite directions. On the one hand, the share of foreign trade in the Soviet national income is understated, because of a quite insufficient allowance for the overvaluation (in terms of internal prices) of the *valuta* ruble in which foreign trade statistics are expressed. On the other hand, the share of machinery exports in total output of machinery, as given by Berliner, reflects a significant underestimate of the output of Soviet machinery, the error being due to a misinterpretation of official Soviet indices. This may be explained for the statistically-minded as follows: The error consists in treating the "repairs" component of the "machinery and metal-working" index as if it referred only to "special railway rolling-stock repair plants," whereas this is but one of ten known categories of "repair" activity falling under this head, and this upsets Berliner's calculation of the share of machinery within this category, which is based on the assumption that "repairs" were only of negligible importance.

But these are minor criticisms, which in no way detract from the value of this admirable and timely book. Not the least of its merits is the clarity and conciseness of the style of writing. May there be more like it.

A. NOVE
London School of Economics and Political Science

Techniques of Population Analysis. George W. Barclay. Wiley, New York; Chapman and Hall, London, 1958. xiii + 311 pp. Illus. $4.75.

The purpose of this volume is to provide training (without benefit of lectures) in techniques of population analysis to persons who are not statisticians and who have had no prior experience in analyzing census or vital registration statistics. As a result, the book is written in simple fashion and is quite nontechnical.

The subjects covered range from "The

nature of demography" through "Rates and ratios," measurement of birth and death rates, measurement of the growth of population and migration, and, finally, measurement of "Manpower and working activities." Illustrative materials are drawn from the population censuses and vital statistics of countries throughout the world.

Considering the purpose for which this volume was prepared, the author has done an excellent job. Only the chapter on "Manpower and working activities" is weak; it fails to get at the heart of the definition of working force and of the methodologies available for studying this subject. This topic is by far the most difficult in all population analyses and very probably cannot be treated in as simplified a fashion as some of the other topics.

Various other volumes have been written on demographic techniques, some by actuaries, some by United Nations personnel, and some by university people and other demographers. Without exception every other such volume which I have seen was written for readers who had some statistical or mathematical training and some familiarity with censuses and vital statistics. When writing for these "more learned" audiences, obviously, it is possible to include more sophisticated techniques and to examine all the procedures much more carefully than Barclay was able to do when writing for a relatively unsophisticated reader.

This book can probably be used as a text in high schools, and certainly in the first or second year of college. For more advanced American college students it will be useful as supplementary reading.

A. J. JAFFE
Bureau of Applied Social Research, Columbia University

Landmarks of Tomorrow. Peter F. Drucker. Harper, New York. 1959. xii + 270 pp. $4.50.

Anyone with a clear memory of the world of 25 years ago knows how fantastically different that world was from this one—different not only in the level of production and income but different also in national policies and international relations, in the problems that concern individuals and governments, in man's expectations and aspirations for the future. Yet the world of 25 years ago was the modern world of big business, high-speed transportation and communication, Freud, revolutionary scientific theory, new invention, and social change.

What then is this world? Drucker calls it the "post-modern" world and describes one of its fundamental features as a changed attitude toward change itself. In the past, change was sometimes thought of as fate, and sometimes as inevitable progress. Change now—and this is the starting point of Drucker's analysis—is deliberately planned. Man has learned enough of science and of management to be able to invent, on demand and to specification, new goods and new social, industrial, and political devices to suit his needs; witness polyethylene, voluntary medical insurance, the Marshall Plan. The basic method is what Drucker calls the organization of ignorance—the systematic review of what must be learned, developed, and constructed to make the desired invention work. This is not new; in this sense Mendeleev "invented" the periodic table, and the Federal Government "invented" TVA. What is new is that innovation is now the norm; man knows how to organize his ignorance; he is prepared to take the risks involved, and to expect enough successes to overbalance the failures. Change is no longer fate or inevitable progress but man's own doing, and thus man must accept responsibility for the future.

Against this background the author sweeps over a wide range of problems: the fate of Communism, the upward struggle of underdeveloped nations, the problems of government, the relations of various centers of power in an industrialized economy, the role of research, and, most emphatically, the need for a philosophy, a theory, a discipline—"a strict discipline of qualitative and irrevocable changes such as development, growth, or decay. We need rigorous methods for anticipation of such changes. We need a discipline that explains events and phenomena in terms of their direction and future state rather than in terms of cause—a calculus of potential, you might say, rather than one of probability. We need a philosophy of purpose, a logic of quality and ways to measure qualitative change."

Drucker does not try to develop this philosophy or discipline. All he does is to ask a lot of hard, thoughtful questions, here and there to show why yesterday's methods cannot possibly solve today's problems, and to organize a wide range of information to show how fundamental and pervasive the change has been. Many of the things he says have been said by others; indeed one of his points is "how obvious the unfamiliar new already is." Sometimes I read with disagreement, sometimes with shock, and sometimes with gratitude for a stimulating synthesis. The whole is provocative reading indeed, for the social scientist or social philosopher, for anyone responsible for management, and for anyone interested in education or the social aspects of science.

Any such book must be partly sermon. The theme of this sermon is responsibility: educated man must accept responsibility for determining the "Landmarks of Tomorrow"; the responsibility lies heaviest on those nations which have acquired the greatest experience and skill in innovation.

DAEL WOLFLE
American Association for the Advancement of Science

Investment in Innovation. C. F. Carter and B. R. Williams. On behalf of the Science and Industry Committee [British Association for the Advancement of Science]. Oxford University Press, New York, 1958. ix + 167 pp. $2.40.

Beginning more than a decade ago, arguments raged in the United Kingdom about the inadequacy of the research and development effort, both in quantity and in effectiveness of organization, and the slowness of industry to invest in innovation. Many conflicting suggestions were advanced. The authors, who are British university economists, have spent most of the intervening period collecting concrete information on these and closely related subjects.

This book is only the filling in a sandwich. A predecessor, *Industry and Technical Progress* (1957), dealt in a particularly thorough manner with the supply of technical personnel. The follow-up study is to be called *Studies in Company Finance.*

After a rather prosaic discussion of the origins of innovation, and an increasingly interesting evaluation of the bases for deciding when and if investment should be made, the authors very sanely conclude that no generally applicable set of rules exist. Before reaching this position they introduce the questions of opportunity (as provided by research and invention), uncertainty (usually greatest in marketing aspects), motivation (profit is seldom the dominant conscious aim in the choice), institutional environment (40 percent of the decisions were forced by external circumstances), capital supply (only a small volume of useful industrial innovation seems to be inhibited by credit restrictions), and the influence of changes in interest rate (which are small as long as the rate moves in the 2 to 7 percent per annum range). Typical resolutions of these questions within individual firms are illustrated in six brief case studies.

The writing seems to be directed to civil servants, directors, managers, and educated policy makers. In a valuable appendix the relevant economic theory is reviewed, and it is demonstrated to colleagues in the economics profession that the present state of Keynesian theory is not very helpful, and that alternative formulations are not at all ex-

plicit. *Investment in Innovation* is an admirable example of analysis, with reasonable inferences drawn from recent experience. It makes no attempt to construct a new system, nor does it incorporate any ingenious devices for bringing about increased outlay for innovation.

RICHARD L. MEIER
School of Natural Resources,
University of Michigan

The Population of Japan. Irene B. Taeuber. Princeton University Press, Princeton, N.J., 1958. xx + 461 pp. Illus. $15.

If a nation the size of Japan had suddenly appeared on the earth on 31 December 1958, it would have been one of the great news stories of modern times. Actually, such a nation did move in on our planet during 1957 and 1958, for world population grew by some 90 million persons during those two years.

Nothing like that has ever happened before in the history of man. It took 200,000 years for the human species to multiply to a billion souls. Then the number doubled to 2 billion in only 2½ centuries. At the current rate of population increase, the present nearly 3 billion of us will grow to 6 billion by the year 2000. The United Nations was not fooling when, in a recent publication, it warned that this unprecedented multiplication of people is "at the very heart of the problem of our existence."

The complexities of the problem of too-rapid population growth surround the problem with an aura of futility. Yet, within just the last few decades, an Asian nation has reversed the upward trend of its birth rate to undergo the most remarkable demographic transition of all time. The *Population of Japan,* a monographic survey by Irene B. Taeuber, records this transition.

Irene Taeuber is the distinguished research associate of the Office of Population Research of Princeton University. She was for many years editor of the *Population Index.* She has traveled widely, thought profoundly, and written wisely on this compelling problem. Her survey of Japanese demography traces developments since the 12th century. The major part of her book is concerned with the fantastic century which intervened between the reluctant welcome given to Perry in 1854 and the end of World War II, when another visitor from the West dictated another agreement under the guns of warships.

The isolated island empire which Perry visited a century ago had a population stabilized, by a "managed" death rate, at about 30 million. A high death rate usually served to keep the high birth rate in balance. When for any reason natural causes failed to take the necessary toll, infanticide was used to redress the balance.

Perry's arrival initiated a social, political, and industrial revolution which upset this traditional system. In the succeeding century Japan's population tripled and she emerged as one of the world's most densely populated countries. In an incredibly short time she shifted from a feudal, Oriental, agrarian culture to an industrial, urban civilization patterned on an alien culture. The Japanese achieved levels of literacy and of living far superior to those of any other Asian country. Amazing advances in science and technology marked this century of change and progress as unique.

In the light of the current world population crisis, Taeuber's detailed account of what has happened in Japan to bring fertility into balance with modern low mortality is a story which deserves the consideration of all thinking persons.

The dramatic decline in the Japanese birth rate since 1945 tends to conceal the very important fact, emphasized by Taeuber, that the beginning of fertility control extended back more than 40 years to a time when national policy favored rapid population expansion:

"Planned limitation existed in the population of Japan in 1920. In the decades after 1920, practices of limitation were diffused over broader geographic areas and accepted by increasing numbers of people in ever-wider ranges of social groups.

"In the years before World War II a major portion of the increasing limitation of fertility among the Japanese was associated with the postponement of age at marriage and the separation of couples by the military service or migration of the husband. The process of fertility decline was continuous, but slow. In the middle 1930's the fertility of the Japanese was far below that of the peasant peoples of the East, but it remained high enough to produce a rather large population increase. . . .

"In the postwar years there has been a rapid spread of contraceptive practice and a nation-wide resort to abortions. There is increasing acceptance of sterilization. The decline in marital fertility has been rapid, and it has extended from Tokyo to the villages of Hokkaido in the northeast and Kyushu in the southwest. This is not the response of an agrarian society in the initial period of its social and economic modernization. It is the response of a literate people who have radios and electric lights, who live in a country with a network of transportation and communication facilities, and who work in major part in activities other than agriculture. The formal facts of changing levels of reproductive behavior, of contraceptive products manufactured and induced abortions performed, and of the diffusion of the various means of limitation singly or in combination contribute little enough to any real knowledge of the changing attitudes and values of the Japanese in the realm of fertility control. They offer even less basis for estimating under what circumstances or with what speed contraception or other types of birth restriction might develop in other Asian populations."

The resort to legalized abortion would not be acceptable in a Western Christian culture. Yet recent surveys have revealed that the practice of abortion is widespread in this country and in Europe. In the light of this fact, it would seem that severe condemnation of Japan's solution would smack considerably of hypocrisy.

Japan, with this sharp application of the reproductive brakes, is today almost at the end of the period when growth of numbers is a problem. The prospect that population stabilization will come within a generation does not exist in any other Asian country. Because of Japan's heavy industrialization and her adoption of modern methods of food production, Taeuber believes that, given full access to world commerce, Japan will be able to care adequately—and at a rising level of living—for annual increases in population that become smaller year by year.

While much of Taeuber's book is highly technical, the lay reader will find kernels of summary and orientation which are fascinating—the chapters on "Marriage," "Fertility," and "The control of fertility" and the chapter on "The demography of war" are especially interesting. The concluding chapters—"Problems, projections and policies" and "The past and the future"—are definitely required reading for anyone who pretends to be really informed concerning the great problem of the world's unprecedented and accelerating multiplication of people.

ROBERT C. COOK
Population Reference Bureau,
Washington, D.C.

The Archeology of Coastal North Carolina. William G. Haag. Louisiana State University Press, Baton Rouge, La., 1958. xi + 136 pp. Illus.

This study reports the results of an archeological program of investigation within the little-known area of the Outer Banks and the adjacent coastal mainland of northeastern North Caorlina. The purpose of the program, which was supported jointly by the National Park Service and the Office of Naval Research, was twofold—namely, to investigate the problem of aboriginal cultural

succession and to uncover any evidence bearing on the fate of a group of colonists (the "Lost Colony") who disappeared shortly after they founded Fort Raleigh (in 1587). Although the program was unsuccessful with respect to the latter aim, a considerable amount of useful data bearing on the former problem was obtained.

Since the area selected was too large for a complete survey, the field strategy was "to obtain representative sites throughout and, where circumstances suggested favorable results, to make test excavations in order to establish the chronological sequence of cultural events" (page 2). Consequently, most of the field work was in the nature of surface collecting, but stratigraphic test excavations were made at five sites, which were the most promising from the standpoint of depth of midden. Cultural materials, principally pottery sherds, were obtained from most of 81 "sites" located on Hatteras, Ocracoke, Bodie, Collington, and Roanoke islands, on the adjacent mainland in the vicinity of the Neuse River, and on Albemarle and Pamlico sounds.

As one might expect in a report of this nature, the bulk of the study is taken up by a description of the individual sites and a technical analysis and comparison of the pottery with that of adjacent regions in terms of temper, paste, surface finish and decoration, and form. However, in two final chapters Haag skillfully combines limited inferences from sparse archeological data with good regional historical data to produce a plausible reconstruction of aboriginal culture history. The latter is divided into an early period (hunter-fisher-gatherers), a middle period (introduction of agriculture), a protohistoric period (a time of numerous contacts with other areas, especially with the interior Piedmont and the Virginia coast and Chesapeake), a historic period (a period of considerable political adjustment), and a displacement of aboriginal culture period (post A.D. 1587).

BERT A. GEROW
Department of Anthropology, Stanford University

The Second (1957) University of Utah Research Conference on the Identification of Creative Scientific Talent. Calvin W. Taylor, principal investigator. University of Utah Press, Salt Lake City, 1958. vii + 255 pp.

The need for identification and support of individuals gifted with creative scientific talent has been increasingly recognized in the United States since the fall of 1957. It is to the credit of the National Science Foundation that since its inception, and particularly since 1954, it has effectively encouraged investigation aimed at discovering and nurturing potentially creative scientists, and it has supported two summer research conferences on this topic, in 1955 and 1957. This report of the second conference, held in Brighton, Utah, 17–20 Aug. 1957, has the same form as that of the earlier conference [reviewed in *Science* **125**, 813 (1957)]; it is prepared from a complete transcript of proceedings and presents 15 original papers, discussion of each paper, and two committee reports. Restrained and judicious editing by the participants has served to retain the liveliness of the discussions; the enthusiasm of the participants is apparent and contributes to the readability of the product.

A reader in search of hypotheses concerning characteristics of the creative scientist and methods for identifying him will find that almost every contribution to the conference offers stimulating suggestions. Of particular interest is the view of a criterion committee, which reported to conferees, "The measure of a creative product should be the extent to which it restructures our universe of understanding." The committee report continues by suggesting means for estimating degree of creativity for established scientists and proposes a series of testable hypotheses which specify promising relations between this estimate and other variables (for example, the diversity of a scientist's contributions).

To one hoping to discover proven methods for the successful selection of promising scientific talent, the report will be provocative but disappointing. In the empirical studies cited, attempts to distinguish creative scientific achievements or to discriminate between creative and noncreative scientists on the basis of academic grades or standard aptitude measures were not remarkably successful. While in two or three studies certain aptitude measures showed some promise, the more typical finding was one of no relationship between this class of variables and creative scientific achievement. In explanation, the report does not rule out inadequate criteria of creativity, unsatisfactory predictor variables, or inappropriate experimental design and analysis. Nevertheless, there remains the tenable conclusion that conventional measures of intelligence and academic achievement are not good measures of creativity. Participants emphasize the probably greater value, as indicators of creativity, of certain special aptitudes (such as the aptitude for divergent thinking), of certain qualities of temperament (for example, independence versus conformity), and of certain kinds of motivation (for instance, inquisitiveness of mind); it is suggested that new tests be developed where none now exist for measuring such variables.

Not the only challenge contained in the report is directed toward research on identification of creative scientific talent. Repeatedly participants emphasize the danger that academic training procedures or environmental working conditions may inhibit rather than excite the creative impulse. In the words of one, "More good people are spoiled scientifically and in their creative thinking by being frightened than [by] anything else." While this report will affect most directly the research area which it represents, its relevance to the training of scientists should not be overlooked.

LYLE V. JONES
Psychometric Laboratory, University of North Carolina

Symposium on Sociological Theory. Llewellyn Gross, Ed. Row, Peterson, Evanston, Ill., 1959. ix + 642 pp. $7.25.

This book of 19 essays covering theory in sociology is as good as anything available. Happily, one advantage—not more than three of the essays are long-winded or dull—will assure recognition of the book's merit. The essays range from a confessional "how-to-do-it" piece, by C. Wright Mills, through an artfully complex but not difficult "axiomatization" of linguistics, by Joseph H. Greenberg, to Anatole Rapoport's "Uses and Limitations of mathematical models in social sciences."

Unfortunately, however, a prejudiced outsider will probably leave the book with his prejudices intact. The difficulty is stated forthrightly in Robert Bierstedt's article: "The important lacuna . . . is that between metasociological theory on the one hand and sociological theory on the other or, stated differently, between methodological theory and substantive theory. Metasociological theory is now a highly developed discipline; sociological theory, on the contrary, is still a weak and pallid thing whose pursuit receives no special encouragement within the profession and whose major achievements frequently come not from academicians, but from novelists, journalists, publicists, and those relatively few sociologists who are not afraid of epithets like 'unscientific'." Even Greenberg says of linguistics, which vies with economics for being the most thoroughly "scientific" of the behavioral sciences, that it "does not at present have a general theory as this term is employed, e.g., in physics. What can be axiomatized is rather the descriptive methodology of the science."

There is a lot of "metasociological theory" in this book. Sociologists must, apparently more than other scientists, recognize that all "facts" are perceived phenomena and that the statement of a

fact is a statement of the relationship between perceiver and perceived. The concern with the perceiver is neither to be wondered at nor condemned. However, one danger does exist: the perceiver may become the subject matter, and social relationships (which are, after all, what sociology studies) may be left out in the cold.

Sociology, like any science (and Carl G. Hempel's lucid critique "The logic of functional analysis" shows that the word *science* is not a misnomer) is a mode of perceiving. Taking a cue from the brief résumé by Rapoport of simple game theory, we can note that scientific procedure demands players and rules. But the sociologist is both player and game analyst. Sociologists study a game (persons engaging in social relationships); their procedure is also a game (sociologists watching people engaging in social relationships). The trouble seems to be, in this complex game, keeping one's eye on the ball.

PAUL BOHANNAN
Department of Economics & Sociology, Princeton University

Physical Sciences

The Neutrino. James S. Allen. Princeton University Press, Princeton, N.J., 1958. viii + 168 pp. $4.50.

I have, on occasion, wondered about the sort of world we would experience if our planet, Earth, were to have a perpetual cover of cloud over its entire surface, as does Venus. No man, in this circumstance, would ever have seen the sun or the moon—or even one star! Would man ever have emerged from the grey winter of primitive knowledge to feel the warm shafts of intellectual sunlight that now occasionally pierce his ignorance? Certainly, wonderment upon gazing into the clear sky and the practical lessons of celestial mechanics would have been beyond the realm of his experience.

Yet there would have been those who sat by the ocean shore, watching the rise and fall of the tides, who counted the periods of night and day and season following season. Some would try to find the thread connecting such mysterious events to the more prosaic things of life. In the gradual building, through the years, of intellect with intellect, a sudden flash of understanding might have occurred in the mind of one man and suggested to him the existence of the sun.

One can see the initial disbelief in the eyes of his colleagues (those who adhered to theories of great whales in the depths who sloshed the seas with gigantic tails, and the like). But as those less skeptical than most used the strange hypothesis of a "sun" that must remain forever concealed from the eyes of men to build a "sun theory" that would account for the tides and the night and day, disbelief might have turned into acceptance. But what a strange object this "sun" must be—describable to some extent, but hardly to be understood by mortals!

Providence has permitted man to see the stars, but at the other extreme of experience the vast regions of the subatomic are forever obscured from our vision. The myriad spaces of the very small, where reality begins, are beyond the range of our senses; and so we sit on the shores of a sea poorly charted—and wonder.

A quarter of a century ago, however, to one of our number, Wolfgang Pauli, came a flash of understanding. In his mind's eye he saw the neutrino. Rejected at first as just a poor excuse for forgetting the whales lashing our theories with improvident tails. Pauli's thought was soon embedded in our science. There it has continued to grow, bearing fruit as one of the most basic ideas of our times, while its consequences, one by one, are comprehended and fitted into place. But what a strange object this "neutrino" must be—describable to some extent, but hardly to be understood by mortals!

Allen accomplishes this description as adequately as a scientist of today can hope to do. He proceeds in a most readable but careful manner to lay the case for the neutrino before the colleagues of Wolfgang Pauli. In his eight chapters Allen reviews the experimental evidence and the theoretical case for the reality of the neutrino.

To compress into 163 pages of concise statement the volume of extant literature concerning the neutrino is no mean achievement. Allen relies heavily, of course, on references to the detailed papers to make the rigorous case, but in so doing he always keeps the principal threads of reasoning clearly in sight. The fine points of technique, experimental and theoretic, must be sought through additional reading.

Major puzzles concerning the neutrino are also treated. Is the neutrino of meson decay the same as that of nucleon beta decay, and as that emitted by nucleon capture of mu mesons? Is the strange new particle in the nuclear firmament indicative of a universal Fermi interaction? And is this poltergeist of modern physics the principal agent in the startling denial of the cherished parity rule?

Explaining some puzzles while it uncovers others, Pauli's and Fermi's neutrino continues to be a fascinating subject for today's physicist. That the story is far from complete is underlined by Allen in his preface, wherein he states that his volume should be considered a progress report of neutrino physics through May 1957. He expresses the common belief that the subject is far from closed and that active research in the field will continue. I hope that Allen is even now assembling the sequel to his first report, and that he will have much that is new and illuminating to present in his next volume.

CLYDE L. COWAN
Department of Physics, Catholic University of America

Géologie de l'uranium. Marcel Roubault. Masson, Paris, 1958 (available from Stechert-Hafner, New York). 462 pp. Illus. $13.

Marcel Roubault is director of the School of Applied Geology and Mineral Exploration, and a professor on the faculty of sciences, of the University of Nancy, and he has been president of the Committee on Mines of the Atomic Energy Commission of France. This book was written with the collaboration of Georges Jurain of the faculty of sciences of the University of Nancy. A preface by Francis Perrin, high commissioner of Atomic Energy for France, is included. Under such authorship it may be assumed that the work has met with the approval of the French Atomic Energy Commission.

More than half of the book (282 pages) includes a survey of the geological features concerned with the occurrence of uranium and thorium. Heretofore, the role of France in the development and exploitation of uranium resources has been given less attention than developments in other parts of the world. Roubault has filled this gap by writing an excellent French text in which a large, well-illustrated section is devoted to uranium occurrences in France; another fair-sized section is devoted to occurrences in Madagascar. This is a welcome addition to uranium literature. Further geological discussions of occurrences in Europe, as well as of localities in Australia and South America, and brief descriptions of deposits in the U.S.S.R. are included. Discussions of the Belgian Congo, South Africa, the Colorado plateau, and the Canadian shield are also given.

One section (51 pages), illustrated with conventional figures and two exceptional colored plates, is devoted to uranium minerals. Another section (50 pages) is devoted to prospecting and covers detectors, probes for drill holes, airborne surveys, and radioactive anomaly maps. A short section is devoted to the reserves of uranium and thorium. The minerals of thorium and the occurrences of thorium are also covered.

The text contains a number of well-chosen photographs illustrating textures of uranium ores. The numerous geologic

diagrams of mining areas and sections of uranium deposits, particularly of occurrences in France and elsewhere in Europe, will be found useful.

The emphasis of the book is primarily what one would expect from an able student of mineral deposits who writes for others in the same field. The principles of uranium occurrence take precedence, and an abundance of illustrative material has been introduced to support the text. Future books, written in English, on the geological occurrence of uranium will doubtless show the influence of this French text.

PAUL F. KERR
Department of Geology, Columbia University

Manual on Rockets and Satellites. vol. 6, *Annals of the International Geophysical Year, 1957–1958.* L. V. Berkner, Ed. Pergamon, New York, 1958. xx + 508 pp. Illus. $25.

One of the greatest scientific achievements of recent times—the International Geophysical Year—has just been completed. A very large part of the Geophysical Year program was centered around the use of rockets and satellites, the subject of this book. The book is a compilation of articles by authors from all of the many countries which participated in this gigantic, world-wide undertaking. The fact that publication of this book was possible, that the IGY itself was possible, is a tribute to the willingness of scientists everywhere to cooperate in a difficult, complex, and closely integrated scientific effort.

Lloyd Berkner, who edited the volume, was the reporter for rockets and satellites of the Comité Spécial de l'Année Géophysique Internationale; he was greatly assisted in accumulating and preparing the information for publication by associate editors Reid, Hanessian, and Cormier. The editors are also indebted to scientists too numerous to mention who were responsible for the individual articles. Although it was published in 1958, the book was prepared in the middle of the IGY effort; in the main, therefore, it discusses the plans of the various countries for carrying out their IGY programs in the areas of satellite research and rocket probing of the upper atmosphere. Now that the IGY is officially over and has been succeeded by the program of International Geophysical Cooperation, one can see in retrospect that the planning for the IGY was good; the experiments as actually carried out are described quite well in this book.

An excellent introduction by Berkner gives in capsule form the reasons for the IGY rocket and satellite effort and explains the principal experiments that were planned to implement this effort. The book then describes many of the programs in detail, each chapter being made up mainly of articles by individual experimenters. Despite the diversity of the contributors, there is good continuity.

The first 100 pages are devoted to a description of the rocket programs planned by Australia, Canada, France, Japan, the U.S.S.R., the United Kingdom, and the United States. This section is replete with photographs and drawings of the experimental equipment and of the rockets. Included also are reports of some of the earlier results—data on pressures, densities, and temperatures in the upper atmosphere. The section ends with a detailed schedule of the types, dates, locations, and principal experiments of the United States rocket firings.

It is interesting to note that the principal objectives of the U.S.S.R. and United States programs were remarkably similar. These dealt primarily with the following areas of research: structural parameters and optical properties of the atmosphere; ultraviolet, x-ray, and corpuscular solar radiation; aurorae; cosmic rays; ionospheric phenomena; the magnetic field of the earth; micrometeors and meteorites; and physical and chemical processes in the upper layers of the atmosphere.

The next 330 pages of the book give a description of the satellite programs planned by the United States and the U.S.S.R. This is an excellent treatise on the problems that arise in the launching and use of close-in earth satellites. This section, again, is a compilation of separate articles, but it is a well-integrated, effective treatment of the satellite problem and of the principles employed by these two countries to conquer the problem during the IGY. The section deals first with general satellite information, with problems relative to the orbit and its determination, and with the scientific information that can be garnered from the expected perturbations of the orbit. This is followed by a presentation of the U.S.S.R. satellite program, in which the experimentation is dealt with in very general terms; the experimentation plan closely resembles that for the rocket program. Following this is a treatment of the United States satellite program; much more detailed information is given on the launching vehicles and on the experiments planned. Quite a bit of space is given to the optical and radio satellite tracking programs and to the effort that was made to interest groups in the United States and abroad to participate in them.

One of the major problems in an effort of this magnitude is that of gathering the large number of data received and of assembling them in world data centers where they will be available to students for years to come. The planning for this is treated in the 20 pages that follow. The book closes with two addenda, which report the first three successful satellite launchings.

This book is of great interest in that the reader will see evidence of the tremendous effort made by many groups to allow man to break away from the environment in which he has been confined since the beginning of history. The plan was successful. New objects in nature have been created, and the door is now open for us to make full use of this new frontier. Our knowledge of the universe had been limited to what we could see through our murky atmosphere. Now, through the medium of satellites, we can see the rest of the universe in its full spectrum, and we are only beginning to sense the increase in our knowledge which will thereby be made possible. For any who desire an understanding of the problems and pains involved in work with rockets and satellites, this book brings together as does no other single source a wealth of useful information.

JOHN P. HAGEN
Vanguard Division, National Aeronautics and Space Administration

Geology of the Great Lakes. Jack L. Hough. University of Illinois Press, Urbana, 1958. xviii + 313 pp. Illus. $8.50.

The Great Lakes occupy deep basins in ancient crystalline and sedimentary bedrock, but they are truly a product of the Ice Age. Hough has published a summary of information on the lakes and their formative history, but in the same year that the basic concept of multiple glaciations has been subject to severe criticism. Accordingly, this book represents an era of thought on the records of the Great Lakes which may be subject to revisions of interpretation in the future.

Changes of concept in lake history have been many over the years. In 1915 Frank Leverett and Frank B. Taylor summarized the information to that time in a U.S. Geological Survey monograph. Twenty-four years later the evidence for an important submerged lake stage unknown to those authors was discovered and described by George M. Stanley; this altered the accepted understanding of the historical record and introduced new problems. These Hough, whose long experience in the Great Lakes has given him extensive knowledge of their sediments, has endeavored to

explain. The hard-rock geology and the qualities of the lake water, temperatures, and currents are amply treated. Maps of the bottom topography of each lake are furnished, with a contour interval of 100 feet.

Most of the book is devoted to glacial and postglacial history, interpreted against a background of four glacial stages and relatively much longer interglacial ages. The duration of time since the Ice Age and of successive intervals thereafter is critically discussed in the light of carbon-14 dating. The author confesses an attempt "to present a review which proceeds from the more probably correct interpretations to inferences that are less well founded, and to indicate the degree of doubt or certainty existing in the conclusions."

His more controversial points include a Two Creeks low-water stage; the concept of Valders and Cochrane deposits as tills resulting from ice readvances rather than deep-water deposits of iceberg drift; a claim that Lake Algonquin evidence is lacking in the Superior basin; and a return to consideration of supposed marine waters (Gilbert Gulf) in the Ontario basin. Hough considers the name *Champlain* no longer appropriate and suggests "St. Lawrence Sea" to replace it. This may create difficulties of nomenclature with respect to a classic time unit now being recognized in the Hudson Bay area and on the Pacific Coast.

Such incidents furnish problems for research in the future, and this research will be given stimulus by this interesting treatise.

RICHARD J. LOUGEE
Graduate School of Geography,
Clark University

Climatology and Microclimatology. Proceedings of the Canberra Symposium. UNESCO, Paris, 1958 (order from Columbia University Press, New York). 355 pp. Illus. $11.

In October 1956 the Advisory Committee on Arid Zone Research of UNESCO sponsored a technical meeting in Australia. The theme was arid-zone climatology. This volume contains 50 papers which were presented at the meeting. It is a companion to an earlier UNESCO publication, *Arid Zone Research X* (Paris, 1958). This preceding volume contained the eight introductory addresses on the major phases of arid-zone climatology and microclimatology which opened the eight sessions of the symposium.

As one might expect, a wide compass of topics is covered. The session titles indicate this: "Evaporation and water balance"; "Radiation and thermal balance"; "Interrelationships of climate and flora"; "Interrelationships of climatic elements and fauna"; "Microclimate of man and domestic animals"; "Modification of microclimate"; "Salting and chemistry of rainwater"; "Climatological observational requirements in arid zones."

The papers and the brief summaries of the ensuing discussions are very useful contributions to the subject of arid climates. This shares with other symposium volumes the problem of wide variety in scope and quality. In this case the variation is, fortunately, more in the size of the contributions than in the contents. Some papers are merely extended abstracts. A great many new data are presented. This is partially due to the fact that 31 papers were contributed by Australians and deal with the arid lands on their continent. Much of this material summarizes original research of the authors. Other areas of the globe were represented by—among others—such well-known experts as Thornthwaite, Geiger, Emberger, and Ramdas, so that a high standard of presentation was assured. A discourse by the U.S.S.R. academician Dzerdzeevskii gives a useful survey of aridity indices and defines an evaporation deficit concept which has been useful in the synoptic climatic analysis of dryness in Russia.

Most encouraging is the physical and quantitative approach now being taken in dealing with problems of arid climates that is apparent throughout the volume. This approach permits a clear assessment of the risks of land utilization in arid lands. It also leads to rational attempts at adaptation and amelioration. This symposium brings together the viewpoints of many minds and disciplines. It will stimulate thinking and new basic and applied research into the climatic problems of arid zones. The wisdom of UNESCO in promoting studies along this line is obvious if one considers, in frustration, the presently unusable dry lands of the earth that might help to relieve the increasing population pressure.

This volume on climatology is a worthy addition to the list of earlier UNESCO arid-zone symposia publications, such as those on human and animal ecology and on wind and solar energy. I regret that the anonymity of the editor of this volume prevents me from giving personal credit for excellent bilingual printing and beautiful make-up. The book can be highly recommended to meteorologists, agronomists, ecologists, geographers, and conservationists.

H. E. LANDSBERG
Office of Climatology,
U.S. Weather Bureau

The Physical Theory of Neutron Chain Reactors. Alvin M. Weinberg and Eugene P. Wigner. University of Chicago Press, Chicago, Ill., 1958. xii + 801 pp. Illus. $15.

Research in the neutron physics of reactors is preponderantly done in large laboratories which generally issue their own reports. Since few of these reports are published in journals, even in abbreviated form, it has not been easy to infer from the readily accessible literature just what are the principle problems of the moment, and what methods are being used on them.

Weinberg and Wigner have now given us a work which goes far toward filling the partial void. This is a book which begins properly with a selective review of relevant parts of the theory of nuclear reactions, which proceeds to a thorough treatment of the transport of neutrons interacting with matter, and which then applies these subjects to the theory of neutron chain reacting systems. To this extent the book resembles others which have appeared in the past. The features which most distinguish this work from earlier ones are its thoroughness, its careful consideration of fundamental concepts, and the modern character of the treatment. For instance, this is the first general book on reactor theory to take into account the wide use of high-speed computing machines in dealing with reactor calculations, and to discuss the methods used.

These features, as well as the clear and precise language used, elevate the book into a class by itself. It will without doubt now become the standard work on reactor theory, both for reference and for teaching. As a text, some will probably choose to use it in advanced courses. It need by no means be used only at this level, however, because *The Physical Theory of Neutron Chain Reactors* presupposes no required prior knowledge of reactor theory. A good course in nuclear physics is, however, a prerequisite.

It is a pleasure to recommend this book, with no essential reservations, to all concerned in the field.

HERBERT KOUTS
Brookhaven National Laboratory,
Upton, New York

The Pulse of Radar: The Autobiography of Sir Robert Watson-Watt. Dial Press, New York, 1959. x + 438 pp. $6.

In 1925 King George V asked scientists of the British Admiralty whether they could not detect aircraft by radio echo ranging in a fashion similar to the detection of submarines acoustically. His Majesty's scientists did not think the

suggestion was practicable. Ten years later the director of research of the Air Ministry asked Robert Watson-Watt what he thought about the use of death rays for air defense. Watson-Watt, who had directed the study of radio noise and radio storm tracking since World War I, replied that it would be difficult to obtain damaging radiation effects at a distance but that it would be quite practical to detect and to track aircraft by means of radio pulses. The government gave immediate support. Within a month the concept had been tested, and within a year the first coastal warning stations were being designed. In the short 4 years before the start of World War II, early warning, ground control of interceptors, field army defense, air-to-ship, ship-to-ship, and air intercept radars were designed, tested, and put into production. From this beginning came the many other radar systems, radio beacons, and radio navigation systems which played such a vital role in the last war.

The Pulse of Radar is this story and the autobiography of Sir Robert. The two are intimately related. This is primarily the history of the British program, since that is the story the author knows personally and since the development of radar in the United States has been adequately glorified in other works. The British program is the really exciting one.

This volume has value not only as stimulating technical history but, perhaps even more, because of the light it sheds on the science-government-military relationships which made possible such dramatic progress. Even though the problems of military science are now much more complicated and the incentive may not be as great as it was then, still, much could be done to reduce the lead time for military research and development. Much can still be learned from the experiences described in this book.

W. A. HIGINBOTHAM
Brookhaven National Laboratory, Upton, New York

Les problèmes aux limites de la physique mathématique. Introduction à leur étude générale. H. G. Garnir. Birkhäuser, Basel, Switzerland, 1958. 234 pp. Illus. F. 29.

The simple Dirichlet problem is that of finding the temperature distribution in a solid when the temperature at the surface is prescribed; the Neumann problem differs only in that the heat flow across the surface, rather than the temperature itself, is prescribed. These problems are mathematically equivalent to those of finding a potential distribution when the potential at the surface is prescribed in the one case, the potential drop across the surface in the other. Either problem leads to that of finding a function u which satisfies

$$\partial^2 u/\partial x^2 + \partial^2 u/\partial y^2 + \partial^2 u/\partial z^2 = 0$$

throughout the region while at the boundary either the value of u itself or that of its normal derivative is prescribed. By including additional terms involving the function itself, and perhaps its first and second derivatives with respect to time, one obtains the mathematical conditions satisfied by the concentration of a solute diffusing through a solvent, the flux of neutrons in a nuclear reactor, the amplitudes of propagated waves, the displacement of an elastic medium subject to small perturbations—to mention only a few of the concrete applications. A powerful tool for the construction and study of the solutions of these problems is provided by the formation of a Green's function, which amounts to forming certain special elementary solutions which, when properly compounded, provide the solution actually required.

The monograph under discussion generalizes the problem to n dimensions and phrases the boundary conditions in more general terms, permitting, in particular, the Dirichlet condition to hold in certain areas and the Neumann condition to hold elsewhere along the boundary. The treatment is strictly modern, being phrased in terms of Hilbert spaces and utilizing Schwartz distributions. However, the necessary theory is developed at the outset, only a background in the theory of real and of complex variables, including some acquaintance with Fourier and Laplace transforms, being presupposed.

A. S. HOUSEHOLDER
Oak Ridge National Laboratory

Economics for the Mineral Engineer. Edmund J. Pryor. Pergamon, New York, 1958. 254 pp. Illus. $6.

Traditionally, the mineral beneficiation engineer has concerned himself with research and plant design. The problems of economics and management in the mining industry have been handled generally by those connected with development and ore production. Because of the ever-growing importance of ore concentration, this relationship is changing. It is essential that the mineral dresser of the future be well informed on the impact of costs, markets, and industrial relations.

There have been numerous books on mineral economics and mine valuation, all directed toward the geologist and the mining engineer. This is the first written specifically for the beneficiation engineer, or the mineral engineer, as he is called throughout much of the British Empire. Such a treatise is long overdue and should be of value to the teacher and student of ore treatment. The book is designed for the advanced student or the young engineer-supervisor aspiring to management, rather than for the undergraduate. The author is a lecturer at the Royal School of Mines, with managerial and consulting experience. His use of the "King's English" is exceptional—a definite advantage in educating our engineers to write well.

The opening chapters present a concise exposition on the prospecting and sampling of ore deposits. The coverage of accounting as it relates to economics is based on British methods and symbols, and this tends to confuse the American student somewhat. However, the presentation of specific data on mill records and mill construction are of particular value to the neophyte. A section on "new plants" offers practical and sound advice.

The real value of the book lies not so much in specifics as in the philosophies it expounds. This is particularly true in the coverage given management, labor relations, and professional ethics. Here are points too seldom presented to the engineer in his highly technical training. The enlightened view in personnel problems and the development of social conscience, particularly in foreign operations, are stressed as necessities.

Since the book touches briefly on many subjects and lists an ample number of references, it should stimulate additional reading on mineral economics. Some chapter revision seems warranted. Certainly "Incentive bonus" and "Hiring and firing" would be better under "Management" than under "Mill records." The "Glossary" is a definite contribution, containing definitions often hard to find.

EUGENE P. PFLEIDER
Department of Mining Engineering, University of Minnesota

Introduction à l'étude des variétés kählériennes. Publications de l'Institut de Mathématique de l'Université de Nancago, VI. André Weil. Hermann, Paris, 1958 (order from Pierre Berès Inc., New York). 175 pp.

A surface, in Euclidean space, can be examined from (at least) two points of view. The Euclidean concept of distance induces, on the surface, a metric which has found its historical expression, in terms of local coordinates, by means of a quadratic differential form for arc length. On the other hand, Euclidean space can be embedded in complex projective space so that Euclidean geometry

becomes a branch of projective geometry.

These two points of view dominated the development of geometry during much of the 19th and early 20th centuries. Each made notable contributions to mathematical knowledge, but the paths of development were so divergent that the differential geometer and the algebraic geometer of 40 years ago often had little in common. Yet new concepts were quietly in the making; even though Kähler's original note, in 1933, created no great stir, today there are signs of a developing unity within geometry that attest to the importance of Kähler's concept and of recent work by Hodge, Kodaira, and others.

Although a Kählerian space, like the surfaces of classical differential geometry, carries a Riemannian metric, it is a complex analytic manifold rather than a sufficiently differentiable real one. In the second place, a Kählerian space induces in its tangent space (the space of differentials) a Hermitian geometry rather than an elliptic geometry. As a result, the class of Kählerian spaces includes not only the space of all linear subspaces (of a given dimension) of projective space but, more generally, any subspace which is algebraic and without multiple points.

Weil has done mathematics a great service, for his introduction to the subject should stimulate many mathematicians toward a more active interest in this new area of mathematics. His employment of the techniques of modern algebra and topology is effective and elegant. Of particular interest to the classical algebraic geometer is his treatment, in the final chapter, of theta functions and Abelian varieties.

HARRY LEVY
Department of Mathematics,
University of Illinois

Nuclear Scattering. K. B. Mather and P. Swan. Cambridge University Press, New York, 1958. viii + 469 pp. Illus. $14.50.

The title of this book provides an accurate description of the contents. The authors begin with a brief sketch of the relationship between nuclear scattering information and nuclear forces. A considerable fraction (35 percent) of the book is then devoted to a description of experimental techniques used in charged-particle and neutron scattering experiments. The remainder of the book concerns itself with an extensive description of the analysis of nuclear scattering data, beginning with nucleon-nucleon scattering and extending to a discussion of the scattering by more complex systems using an optical model.

The chapter on the scattering of nucleons by few-nucleon targets provides a useful, concise review of past work in this area. The authors have also summarized certain aspects of high-energy scattering that have not heretofore appeared in book form. There is a very nice discussion (in one of the two appendices) of the way in which the scattering phase shift at zero energy measures the number of bound states in a potential.

It is not clear to me for what audience the authors intended their book. The 164 pages devoted to experimental technique, containing such information as the temperature dependence of the densities of Octoil S and Apiezon B (important as these may be), are not very conducive to keeping the reader's attention focused on the strength and range of the nuclear forces mentioned in the authors' opening remarks. Similar consideration is not given in the book to the problem of extracting reliable numbers from a high-speed digital computer! The treatment of complex systems is rather cursory. Although a great deal of discussion is devoted to stripping reactions, the fission reaction is not listed in the index. Almost no comment is made concerning recent data on either the average or the statistical properties of nuclear scattering widths and spacings. Heavy-ion scattering is also ignored.

Technically, the book is very good. Aside from a few misprints, it is easy to read, and the figures are clear. There are a few stylistic novelties, such as the use of *unreal axis* in place of *imaginary axis* and a carefully alphabetized reference to "Various authors." Because of the considerable amount of research work surveyed by this book, it will be a valuable addition to the research library of any institution engaged in nuclear physics. Considering the cost per page, probably most physicists will watch for it there.

CHARLES E. PORTER
School of Physics,
University of Minnesota

Nuclear Engineering Handbook. Harold Etherington, Ed. McGraw-Hill, New York, 1958. xv + 1857 pp. Illus. $25.

The growth in the number of university courses in nuclear engineering, the publication of textbooks on the subject, and hints of realistic cost estimates for nuclear power indicate that the field of nuclear engineering is approaching adolescence, if not maturity. The appearance of the *Nuclear Engineering Handbook* is another such sign—and a welcome one. This book provides some 1800 pages of useful, well-organized, and authoritative information, and is an excellent one-volume reference for the entire field.

There are 14 sections: "Mathematical data and general tables" (156 pages); "Nuclear data" (36 pages); "Mathematics" (148 pages); "Nuclear physics" (103 pages); "Experimental techniques" (145 pages); "Reactor physics" (121 pages); "Radiation and radiological protection" (142 pages); "Control of reactors" (88 pages); "Fluid and heat flow" (116 pages); "Reactor materials" (192 pages); "Chemistry and chemical engineering" (149 pages); "Nuclear-power-plant selection" (155 pages); "Mechanical design and operation of reactors" (155 pages); and "Isotopes" (58 pages).

It is, of course, impossible to discuss a handbook of this nature in detail in a brief review. The treatment is as up-to-date as the problems of compiling and publishing a handbook permit. The mistakes I have found during a quick survey of the book are such as could easily be corrected in a second edition. The coverage of the material is thorough. I have only one serious reservation with regard to content. There are many data not included in this volume; some can be found, in *Reactor Physics Constants* (ANL-5800), prepared at the Argonne National Laboratory and available at $7 or so per copy from the U.S. Government Printing Office, Washington, D.C. Examples of such data are constants for multigroup calculations; tables of reactivity versus reactor period; more calculation methods; and so on. I would like to see this additional information in future editions of the *Nuclear Engineering Handbook,* so that the cost of keeping up with advances in the field may be kept from multiplying too much.

IRVING KAPLAN
Department of Nuclear Engineering,
Massachusetts Institute of Technology

Modern Materials. Advances in development and applications. vol. 1. Henry H. Hausner, Ed. Academic Press, New York, 1958. xi + 402 pp. $12.50.

This volume is the first of a new series on modern materials. It has been prepared especially for the engineer with broad interests and for the specialist who wants information on materials other than those in his own field of specialization. In these days of rapid development of new materials the engineer has had to become more materials-minded and must therefore acquaint himself with the properties and commercial applications of the many new materials that come on the market.

The editor has assembled the following eight chapters: "Some new developments in wood as a material," by Carl de Zeeuw (59 pages and 11 references);

"Synthetic rubbers for special service conditions," by F. A. Bovey (77 pages and 137 references); "Fiber materials," by T. D. Callinan (43 pages and 77 references); "High voltage insulation papers," by William A. Del Mar (29 pages and 78 references); "Special glasses for nuclear engineering applications," by N. J. Kreidl and J. R. Hensler (25 pages and 42 references); "Characteristic properties of modern ceramics," by John H. Koenig and Edward J. Smoke (29 pages and 26 references); "Germanium and silicon," by Gustav Szekely (33 pages and 65 references); and "Zirconium," by G. E. Miller (80 pages and 104 references). The book also includes 10 pages of author index and 6 pages of subject index.

The authors of the various chapters, all experts in their respective fields, have described their subjects so that the graduate engineer will have no trouble understanding the subject matter even though he is not a specialist in that particular field. My specialty is rubber, and therefore a review of the chapter on rubber is the only one that I can do critically. To prepare this chapter the editor selected one of the country's outstanding polymer and rubber chemists who has reviewed "the newer developments in synthetic rubbers for service under conditions where heat, cold, solvents, oils, electrical stress, or other factors make the common, large-volume types of synthetic rubbers unsuitable." This he has accomplished in an authoritative manner. The other chapters also seem to have been very ably prepared.

In spite of the great diversity of the subjects covered, this first volume should prove to be extremely valuable and interesting to the development engineer and to the student. The appearance of succeeding volumes will eagerly be awaited.

NORMAN BEKKEDAHL
National Bureau of Standards, Washington, D.C.

New Books

Advances in Protein Chemistry. vol. XIII. C. B. Anfinsen, Jr., Kenneth Bailey, M. L. Anson, John T. Edsall, Eds. Academic Press, New York, 1958. 535 pp. $13.80. Contents: "The use of immunochemical methods in studies on proteins" (P. Grabar); "Protein-carbohydrate complexes" (F. R. Bettelheim-Jevons); "The silk fibroins" (F. Lucas, J. T. B. Shaw, S. G. Smith); "Synthesis and chemical properties of poly-α-amino acids" (E. Katchalski and M. Sela).

The Age of Improvement. Asa Briggs. Longmans, Green, New York, 1959. 559 pp. $7.

The American Economy: an Appraisal of Its Social Goals and the Impact of Science and Technology. Proceedings of the Science–Economics Workshop. Joint Council on Economic Education, New York 36, 1959. 160 pp. $2.

Animal Camouflage. Adolf Portmann. Translated by A. J. Pomerans. Univ. of Michigan Press, Ann Arbor, 1959. 111 pp. $4.50.

Antibiotics Annual, 1958–1959. Proceedings of the sixth annual symposium on antibiotics. Henry Welch and Felix Marti-Ibanez, Eds. Medical Encyclopedia, New York, 1959. 1124 pp. $12.

Atomic Medicine. Charles F. Behrens. Williams & Wilkins, Baltimore, Md., ed. 3, 1959. 719 pp. $15.

Atoms Today and Tomorrow. Margaret O. Hyde. McGraw-Hill, New York, rev. ed., 1959. 159 pp. $3.

Basic Physics of Atoms and Molecules. U. Fano and L. Fano. Wiley, New York; Chapman & Hall, London, 1959. 429 pp. $10.

Between Earth and Space. Clyde Orr, Jr. Macmillan, New York, 1959. 261 pp. $4.95.

Brandlehre und Chemischer Brandschutz. Eine einführung in die grundlagen. Ludwig Scheichl. Hüthig, Heidelberg, Germany, 1958. 448 pp. DM. 28.

Il cannocchiale di Galileo e la scienza del Seicento. Vasco Ronchi. Edizioni Scientifiche Einaudi, Torino, Italy, 1958. 248 pp.

Cathartics and Common Sense. William R. Farrar. Lippincott, Philadelphia, 1959. 154 pp. Paper, $1.25.

Cellular and Humoral Aspects of the Hypersensitive States. A symposium held at the New York Acad. of Medicine. H. Sherwood Lawrence, Ed. Hoeber-Harper, New York, 1959. 679 pp. $18.

The Chemistry of Drugs. Norman Evers and Dennis Caldwell. Interscience, New York, 1959. 415 pp. $12.25.

The Chemistry of Industrial Toxicology. Hervey B. Elkins. Wiley, New York; Chapman & Hall, London, ed. 2, 1959. 463 pp. $11.50.

Classification of the Aradidae (Hemiptera-Heteroptera). Robert L. Usinger and Ryuichi Matsuda. British Museum (Natural History), London, 1959. 417 pp. £4.

Colorimetric Methods of Analysis. Including photometric methods. vol. IIA. Foster Dee Snell and Cornelia T. Snell. Van Nostrand, Princeton, N.J., 1959. $15.

Comparative Morphology of Vascular Plants. Adriance S. Foster, and Ernest M. Gifford, Jr. Freeman, San Francisco, Calif., 1959. 566 pp. $9.

Conduction of Heat in Solids. H. S. Carslaw and J. C. Jaeger. Oxford Univ. Press, New York, 1959. 520 pp. $13.45.

Cours d'anatomie comparee des vertebres. Jean G. Baer. Masson, Paris, 1959. Text, 210 pp. atlas, 523 figs. F. 5000.

Creativity. An examination of the creative process. Paul Smith, Ed. Hastings House, New York, 1959. 210 pp. $4.95.

Dangerous Marine Animals. Bruce W. Halstead. Cornell Maritime Press, Cambridge, Md., 1959. 153 pp. $4.

Dendritic Crystallization. D. D. Saratovkin. Translated from Russian by J. E. S. Bradley. Consultants Bureau, New York, 1959. 126 pp. $6.

A Design Manual for Cabinet Furniture. Basic scientific principles concerning its construction. Pergamon Press, New York and London, 1958. 56 pp. $3.50.

Directory of Natural History and Other Field Study Societies in Great Britain. Averil Lysaght, Ed. British Assoc. for the Advancement of Science, London, 1959. 228 pp. 25s.

Economics of American Forestry. Albert C. Worrell. Wiley, New York; Chapman & Hall, London, 1959. 451 pp. $9.75.

Electronics for Everyone. The story of electricity in action: transistors, television, radio, radar, hi fi, video tape, space electronics—what they are and how they work. Monroe Upton. Devin-Adair, New York, ed. 2, 1959. 399 pp. $6.95.

Electrophoresis. Theory, methods, and applications. Milan Bier, Ed. Academic Press, New York, 1959. 583 pp. $15.

Endocrines in Development. Ray L. Watterson. Univ. of Chicago Press, Chicago, Ill., 1959. 155 pp. $4.

Endurance: Shackleton's Incredible Voyage. Alfred Lansing. McGraw-Hill, New York, 1959. 282 pp. $5.

Environmental Conservation. Raymond F. Dasmann. Wiley, New York; Chapman and Hall, London, 1959. 318 pp. $6.50.

Fundamental Aspects of Reactor Shielding. Herbert Goldstein. Addison-Wesley, Reading, Mass., 1959. 432 pp. $9.50.

The Gentle Art of Mathematics. Dan Pedoe. Macmillan, New York, 1959. 143 pp. $3.50.

Group Processes. Transactions of the fourth conference. Bertram Schaffner, Ed. Josiah Macy, Jr. Foundation, New York, 1959. 266 pp. $4.50.

Group Psychoanalysis. B. Bohdan Wassell. Philosophical Library, New York, 1959. 319 pp. $3.75.

Guide de travaux pratiques de zoologie. Paul Brien. Masson, Paris; Desoer, Liège, Belgium, ed. 3, 1959. 272 pp. F. 2100.

Handbook of Computations for Biological Statistics of Fish Populations. Bull. No. 119. W. E. Ricker. Fisheries Research Board of Canada, Ottawa, 1958. 300 pp. $5.

Handbuch der Physik. vol. 37, pt. 1, *Atoms III; Molecules 1.* S. Flügge, Ed. Springer, Berlin, 1959. 445 pp.

Heredity Counselling. A symposium sponsored by the American Eugenics Society and held at the New York Academy of Medicine building. Helen G. Hammons, Ed. Hoeber-Harper, New York, 1959. 127 pp. $4.

Information Theory and Statistics. Solomon Kullback. Wiley, New York; Chapman & Hall, London, 1959. 412 pp. $12.50.

Inside the Living Cell. Some secrets of life. J. A. V. Butler. Basic Books, New York, 1959. 174 pp. $3.50.

Institutions of the U.S.S.R. Active in Arctic Research and Development. Vladas Stanka. Arctic Inst. of North America, Washington, D.C., 1958. 100 pp.

Introduction to Zoology. H. W. Manter and D. D. Miller. Harper, New York, 1959. 700 pp. $7.50.

Jet Propulsion Engines. vol. XII, *High Speed Aerodynamics and Jet Propulsion.* O. E. Lancaster, Ed. Princeton Univ. Press, Princeton, N.J., 1959. 816 pp. $20.

Law and Administration. vols. 1 and 2. Herbert S. Marks, Ed. Pergamon Press, New York, 1959. 1007 pp. $26.50.

Lectures on Nuclear Theory. L. D. Landau and Y. Smorodinsky. Plenum

Press, New York, rev. ed., 1959. 115 pp. $5.25.

Lubrication Science and Technology. vol. 1, No. 2. John Boyd, Ed. Pergamon Press, New York and London, 1958. 120 pp. $10. This is a publication of the American Society of Lubrication Engineers. There are 16 papers by various authors.

The Marriage Bed. An analyst's casebook. Harry F. Tashman. University Publishers, New York, 1959. 303 pp. $4.95.

Mitogenesis. Howard S. Ducoff and Charles F. Ehret. Univ. of Chicago Press, Chicago, Ill., 1959. 127 pp. $3.25.

De Motu Locali Animalium. William Harvey. Edited, translated and introduced by Gweneth Whitteridge. Cambridge Univ. Press, New York, 1959. 175 pp. $10.50.

The New Science. Three complete works: "The universe in the light of modern physics," "The philosophy of physics," "Where is science going?" Max Planck. Meridian Books, New York, 1959. 352 pp. $5.

Noise in Electron Devices. Louis D. Smullin and Hermann A. Hauss. Technology Press, Massachusetts Inst. of Technology and Wiley, New York; Chapman & Hall, London, 1959. 429 pp. $12.

Nuclear Explosions and Their Effects. Publ. Div. Ministry of Information and Broadcasting, Government of India, Delhi, 1958. 340 pp.

Nuclear Spectroscopy Tables. A. H. Wapstra, G. J. Nijgh, R. Van Lieshout. North-Holland, Amsterdam; Interscience, New York, 1959. 142 pp. $8.90.

Organic Chemistry. A short text. George K. Estok. Saunders, Philadelphia, 1959. 284 pp.

The Pharmacology of Plant Phenolics. Proceedings of a symposium held at Oxford, April 1958. J. W. Fairbairn, Ed. Academic Press, New York, 1959. 159 pp. $6.

The Physical Metallurgy of Magnesium and Its Alloys. G. V. Raynor, Pergamon Press, New York and London, 1959. 540 pp. $12.50.

Physical Science. A basic course. John C. Hogg, Judson B. Cross, Kenneth E. Vordenberg. Van Nostrand, Princeton, N.J., 1959. 615 pp. $4.96.

The Pirotechnia of Vannoccio Biringuccio. A volume in the *Collector's Series in Science.* Derek J. Price, Ed. Basic Books, New York, 1959. 504 pp.

Planet Earth. Karl Stumpff. Translated by Philip Wayne. Univ. of Michigan Press, Ann Arbor, 1959. 191 pp. $5.

Plastic Analysis of Structures. Philip G. Hodge, Jr. McGraw-Hill, New York, 1959. 378 pp. $10.50.

Practical Biology for Advanced Level Medical and Intermediate Students. vol. I, *Practical Zoology,* 327 pp., $5.75. vol. II, *Practical Botany,* 183 pp., $4. C. J. Wallis. Thomas, Springfield, Ill., ed. 4, 1959.

Precipitation from Homogeneous Solution. Louis Gordon, Murrell L. Salutsky, Hobart H. Willard. Wiley, New York; Chapman & Hall, London, 1959. 195 pp. $7.50.

Proceedings of the Second World Congress on Fertility and Sterility. vols. 1 and 2. G. Tesauro, Ed. International Fertility

Association and Institute of Clinical Obstetrics of Gynecology, Univ. of Naples, Naples, Italy. 2948 pp. This congress was held 18–26 May 1956, and was attended by 1200 scholars from 65 nations. The papers presented are divided into 15 sections and are published in the author's own language, with summaries in the official languages of the conference–English, French, German, Italian, and Spanish.

Radiographic Atlas of Skeletal Development of the Hand and Wrist. William Walter Greulich and S. Idell Pyle. Stanford Univ. Press, Stanford, Calif.; Oxford Univ. Press, London, 1959. 272 pp. $15.

Regeneration in Vertebrates. Charles S. Thornton. Univ. of Chicago Press, Chicago, Ill., 1959. 119 pp. $3.25.

Research in Psychotherapy. Proceedings of a conference, Washington, D.C., 9–12 April 1958. Eli A. Rubinstein and Morris B. Parloff, Eds. American Psychological Assoc., Washington, D.C., 1959. 301 pp.

Russian-English Glossary of Optics and Spectroscopy. Interlanguage Dictionaries Publishing Corp., 227 W. 17 St., New York 11, 1959. 78 pp. $10.

The Sheep Book. John McKinney. Wiley, New York; Chapman & Hall, London, 1959. 301 pp. $4.96.

Staphylococcus pyogenes *and Its Relation to Disease.* Stephen D. Elek. Livingston, Edinburgh, 1959 (order from Williams & Wilkins, Baltimore, Md.). 774 pp. $15.

Symposia on Child and Juvenile Delinquency. Presented at the American Orthopsychiatric Association. Benjamin Karpman, Ed. Psychodynamics Monograph Series, Station L, Washington, D.C., 1959. 394 pp. $10.

Symposium on Genetic Approaches to Somatic Cell Variation. Given at Research Conference for Biology and Medicine of the Atomic Energy Commission. Oak Ridge Natl. Lab., Oak Ridge, Tenn., 1959. 420 pp.

The Technical Writer. An aid to the presentation and production of technical literature. J. W. Godfrey and G. Parr. Wiley, New York, 1959. 340 pp. $8.50.

Textbook of Microbiology. William Burrows. Saunders, Philadelphia, ed. 17, 1959. 977 pp. $14.

Theory of Relativity. W. Pauli. Translated from the German by G. Field, with supplementary notes by the author. Pergamon, New York and London, 1958. 255 pp. $6.

To Be a Politician. Stimson Bullitt. Introduction by David Riesman. Doubleday, New York, 1959. 190 pp. $3.50.

Trend and Tradition in the Prehistory of the Eastern United States. Scientific Papers, vol. x, American Anthropological Assoc. Memoir 88. Joseph R. Caldwell. Illinois State Museum, Springfield, 1958. 102 pp.

Visual Problems of Color. A symposium held at the National Physical Laboratory on 23–25 September 1957. vols. 1 and 2. Her Majesty's Stationery Office, London, 1958. 757 pp.

The Way Things Are. P. W. Bridgman. Harvard Univ. Press, Cambridge, Mass., 1959. 343 pp. $5.75.

Young Children in Hospitals. James Robertson. Basic Books, New York, 1959. 147 pp. $3.

Index of Books Reviewed in *Science*

25 April 1958 through 17 April 1959

Astronomy

Biochemistry and Microbiology

Biological Sciences

The Biological Action of Growth Substances, H. K. Porter, Ed. (Academic Press; Cambridge Univ. Press), 6 June 1958, 1334

Biological Aspects of Cancer, J. Huxley (Harcourt, Brace), 20 June 1958, 1440

Biological Ultrastructure, A. Engström and J. B. Finean (Academic Press), 28 Nov. 1958, 1335

The Chemistry and Biology of Yeasts, A. H. Cook, Ed. (Academic Press), 26 Sept. 1958, 708

Effect of Radiation on Human Heredity (World Health Organization), 24 Oct. 1958, 999

Embryos and Ancestors, G. de Beer (Clarendon Press), 2 Jan. 1959, 35

Farbenbestimmung in der Biologie, pts. 1–8, J. Paclt (Fischer), 12 Dec. 1958, 1502

The Friendly Fungi, C. L. Duddington (Faber and Faber), 25 Apr. 1958, 969

Frontiers in Cytology, S. L. Palay, Ed. (Yale Univ. Press), 16 Jan. 1959, 145

General Cytochemical Methods, vol. 1, J. F. Danielli, Ed. (Academic Press), 30 Jan. 1959, 266

Genetics, A. M. Winchester (Houghton Mifflin), 9 Jan. 1959, 91

Histology, A. W. Ham (Lippincott), 2 May 1958, 1042

Host-Parasite Relationships in Living Cells, H. M. Felton, Ed. (Thomas), 18 July 1958, 136

Introduction to Biostatistics, H. Bancroft (Hoeber-Harper), 10 Oct. 1958, 835

Livestock Improvement in Relation to Heredity and Environment, J. E. Nichols (Oliver and Boyd), 20 June 1958, 1439

The Mango, S. R. Gangolly, R. Singh, S. L. Katyal, D. Singh (Indian Council of Agricultural Research), 16 May 1958, 1169

Microbial Ecology, Society for General Microbiology, Royal Institution (Cambridge Univ. Press), 4 July 1958, 23

Morphological Integration, E. C. Olson and R. L. Miller (Univ. of Chicago Press), 18 July 1958, 138

The Physical Foundation of Biology, W. M. Elsasser (Pergamon), 13 Feb. 1959, 384

The Principles of Biological Control, H. L. Sweetman (Brown), 16 Jan. 1959, 144

Principles of Field Biology and Ecology, A. H. Benton and W. E. Werner, Jr. (McGraw-Hill), 31 Oct. 1958, 1079

Principles of Physical Chemistry, W. S. Brey, Jr. (Appleton-Century-Crofts), 8 Aug. 1958, 298

Radioactive Isotopes in Clinical Practice, E. H. Quimby, S. Feitelbert, S. Silver (Lea and Febiger), 6 Mar. 1959, 635

The World of the Electron Microscope, R. W. G. Wyckoff (Yale Univ. Press), 22 Aug. 1958, 411

Botanical Sciences

Advances in Agronomy, vol. 9, A. G. Norman, Ed. (Academic Press), 30 May 1958, 1284

Agricultural Botany, N. T. Gill and K. C. Vear (Duckworth), 13 Mar. 1959, 714

Control of the Plant Environment, J. P. Hudson, Ed. (Academic Press; Butterworths), 15 Aug. 1958, 354

Exotica, A. B. Graf (Roehrs Co.), 8 Aug. 1958, 296

Flora of the British Isles: Illustrations, A. R. Clapham, T. G. Tutin, E. F. Warburg; drawings by S. J. Roles (Cambridge Univ. Press), 18 July 1958, 135

Flora Hawaiiensis, book 5, O. Degener (The author), 6 June 1958, 1335

The Grafter's Handbook, R. J. Garner (Faber and Faber), 13 Feb. 1959, 384

Morphology of Plants, H. C. Bold (Harper), 31 Oct. 1958, 1079

The Mushroom Hunter's Field Guide, A. H. Smith (Univ. of Michigan Press), 19 Sept. 1958, 650

Pollen and Spore Morphology/Plant Taxonomy, G. Erdtman, Ed. (Almquist and Wiksell; Ronald Press), 2 Jan. 1959, 35

Quantitative Plant Ecology, P. Grieg-Smith (Academic Press; Butterworths), 26 Dec. 1958, 1620

The Sloane Herbarium, J. E. Dandy, Ed. (British Museum of Natural History), 19 Dec. 1958, 1567

Chemistry

Advances in Catalysis and Related Subjects, vol. 9, A. Farkas, Ed. (Academic Press), 30 May 1958, 1285

Advances in Chemical Physics, I. Prigogine, Ed. (Interscience), 27 Mar. 1959, 833

The Chemical Analysis of Food and Food Products, M. B. Jacobs (Van Nostrand), 20 Mar. 1959, 774

The Chemical Behavior of Zirconium, W. B. Blumenthal (Van Nostrand), 6 Mar. 1959, 635

Chemical Publications, Their Nature and Use, M. G. Mellon (McGraw-Hill), 21 Nov. 1958, 1271

Chemistry of Carbon Compounds, vol. 4, E. H. Rodd, Ed. (Elsevier), 25 July 1958, 194

The Chemistry of the Steroids, W. Klyne (Methuen; Wiley), 7 Nov. 1958, 1131

Chemistry of the Steroids, C. W. Shoppee (Academic Press; Butterworths), 7 Nov. 1958, 1131

Colorimetric Determination of Nonmetals, D. F. Boltz, Ed. (Interscience), 26 Sept. 1958, 709

The Development of Titrimetric Analysis Till 1806, E. R. Madsen (Gads), 23 May 1958, 1235

Gmelins Handbuch der Anorganischen Chemie, System No. 28, *Calcium,* pt. B., sec. 2; System No. 60, *Kupfer,* pt. B, sec. 1; 4 July 1958, 25. System No. 3, *Oxygen,* sec. 3; System No. 42, *Ziroconium*; System No. 43, *Hafnium*; System No. 45, *Germanium*; (Verlag Chemie), 28 Nov. 1958, 1337

Handbook of Chemical Data, F. W. Atack, Ed. (Reinhold), 9 May 1958, 1111

Handbook of Magnesium-Organic Compounds, vols. 1–3, S. T. Yoffe and A. N. Nesmeyanov (Pergamon), 25 Apr. 1958, 975

Inorganic Syntheses, vol. 5, T. Moeller, Ed. (McGraw-Hill), 17 Oct. 1958, 895

Ion-Exchange Resins, J. A. Kitchener (Methuen; Wiley), 13 June 1958, 1386

Nouveau traité de chimie minérale, vol. 3, 18 July 1958, 138; vol. 4, 6 Mar. 1959, 636; P. Pascal, Ed. (Masson).

Organic Colloids, B. Jirgensons (Elsevier), 17 Oct. 1958, 894

Physical Metallurgy of Uranium, A. N. Holden (Addison-Wesley), 27 Feb. 1959, 558

Proceedings of the Second International Congress of Surface Activity, vols. 1–4, J. H. Schulman, Ed. (Academic Press; Butterworths), 12 Sept. 1958, 588

Progress in Organic Chemistry, vol. 4, J. W. Cook, Ed. (Academic Press; Butterworths), 19 Dec. 1958, 1568

Purity Control by Thermal Analysis, M. W. Smit, Ed. (Elsevier), 6 June 1958, 1335

Quantitative Inorganic Analysis, G. Charlot and D. Bézier (Methuen; Wiley), 2 Jan. 1959, 36

Research in Photosynthesis, H. Gaffron, C. S. French, R. Livingston, E. I. Rabinowitch, B. L. Strehler, N. E. Tolbert, Eds. (Interscience), 2 May 1958, 1041

Soviet Research in Catalysis, Chemistry collection No. 3 (Consultants Bureau), 30 Jan. 1959, 263

Soviet Research in Crystallography, Chemistry collection No. 5, vols. 1 and 2 (Consultants Bureau), 6 Feb. 1959, 324

Spot Tests in Inorganic Analysis, F. Feigl (Elsevier), 12 Dec. 1958, 1501

Structure Reports, 1951, A. J. Wilson, Ed. (Oosthock's), 25 July 1958, 196

The Terpenes, vol. 5, J. Simonsen and W. C. J. Ross (Cambridge Univ. Press), 1 Aug. 1958, 246

The Transuranium Elements, G. T. Seaborg (Addison-Wesley), 27 Feb. 1959, 558

Volumetric Analysis, vol. 3, I. M. Kolthoff, R. Belcher, V. A. Stenger, G. Matsuyama (Interscience), 3 Oct. 1958, 766

Earth Sciences

American Agriculture: Geography, Resources, and Conservation, E. Higbee (Wiley; Chapman and Hall), 19 Sept. 1958, 651

Artificial Stimulation of Rain, H. Weickmann and W. Smith, Eds. (Pergamon), 2 May 1958, 1044

Atmospheric Explorations, H. G. Houghton, Ed. (Technology Press of MIT; Wiley; Chapman and Hall), 26 Sept. 1958, 711

The Black Fens, A. K. Astbury (Golden Head Press), 6 Feb. 1959, 323

Conservation, D. C. Coyle (Rutgers Univ. Press), 25 Apr. 1958, 967

Descriptive Meteorology, H. C. Willett and F. Sanders (Academic Press), 27 Mar. 1959, 833

Directory of Geological Material in North America, J. V. Howell and A. I. Levorsen (American Geological Inst.), 30 May 1958, 1286

The Earth and Its Gravity Field, W. A. Heiskanen and F. A. V. Meinesz (McGraw-Hill), 20 Feb. 1959, 460

The Effects of Atomic Radiation on Oceanography and Fisheries, (Natl. Acad. of Sciences–Natl. Research Council), 26 Sept. 1958, 709

Elementary Seismology, C. F. Richter (Freeman), 20 Feb. 1959, 459

Exploring the Atmosphere's First Mile, vols. 1 and 2, H. H. Lettau and B. Davidson, Eds. (Pergamon), 4 July 1958, 24

Geography in the Twentieth Century, G. Taylor, Ed. (Philosophical Library; Methuen), 2 May 1958, 1041

The Geology of South Australia, M. F. Glaessner and L. W. Parkin, Eds. (Melbourne Univ. Press), 27 Mar. 1959, 832

The Geology of Uranium (Consultants Bureau), 13 Mar. 1959, 713

Graphic Methods in Structural Geology, W. L. Donn and J. A. Shimer (Appleton-Century-Crofts), 13 June 1958, 1385

Introduction to Historical Geology, R. C. Moore (McGraw-Hill), 27 Feb. 1959, 561

Introduction to Meteorology, S. Petterssen (McGraw-Hill), 12 Dec. 1958, 1502

Matter, Earth, and Sky, G. Gamow (Prentice-Hall), 12 Sept. 1958, 587

National Advisory Committee on Research in the Geological Sciences, Canada, Eighth Annual Report, 1957–58 (Geological Survey of Canada), 17 Apr. 1959, 1021

Nature is Your Guide, H. Gatty (Dutton), 29 Aug. 1958, 469

The Pattern of Asia, J. E. Brush, S. McCune, A. K. Philbrick, J. R. Randall, H. L. Wiens; N. Ginsburg, Ed. (Prentice-Hall), 22 Aug. 1958, 411

The Planet Earth, D. R. Bates, Ed. (Basic Books), 23 May 1958, 1234

Physical Geology, L. D. Leet and S. Judson (Prentice-Hall), 12 Dec. 1958, 1500

Soil-Plant Relationships, C. A. Black (Wiley; Chapman and Hall), 18 July 1958, 138

Treatise on Marine Ecology and Paleoecology, vol. 1, J. Hedgpeth, Ed.; vol. 2, H. S. Ladd, Ed. (Geological Soc. of America), 11 July 1958, 82

The World Beneath the Waves, G. Doukan (De Graff), 25 Apr. 1958, 965

History and Philosophy of Science

The Admirable Discourses of Bernard Palissy (Univ. of Illinois Press), 20 June 1958, 1439

Adventures in Medical Education, G. C. Robinson (Harvard Univ. Press), 29 Aug. 1958, 469

Agricola on Metals, B. Dibner (Burndy Library), 8 Aug. 1958, 297

Amid Masters of Twentieth Century Medicine, L. G. Rowntree (Thomas), 13 Feb. 1959, 384

Anatomist at Large, G. W. Corner (Basic Books), 26 Sept. 1958, 710

Robert Boyle and Seventeenth-Century Chemistry, M. Boas (Cambridge Univ. Press), 13 Mar. 1959, 714

Brighter than a Thousand Suns, R. Jungk (Harcourt, Brace), 26 Dec. 1958, 1619

The Chemical Industry during the Nineteenth Century, L. F. Haber (Clarendon Press), 19 Sept. 1958, 651

Copernicus, A. Armitage (Yoseloff), 25 Apr. 1958, 972

Darwin's Century, L. Eiseley (Doubleday), 27 June 1958, 1493

Histoire générale des sciences, vol. 1, R. Taton, Ed. (Presses Universitaire de France), 25 Apr. 1958, 973

A History of Magic and Experimental Science, vols. 7 and 8, L. Thorndike (Columbia Univ. Press), 9 Jan. 1959, 90

A History of Mathematics, J. F. Scott (Taylor & Francis), 29 Aug. 1958, 469

A History of Nutrition, E. V. McCollum (Houghton Mifflin), 25 Apr. 1958, 968

History and Philosophy of Science, L. W. H. Hull (Longmans, Green), 17 Apr. 1959, 1019

A History of Public Health, G. Rosen (M.D. Publications), 31 Oct. 1958, 1080

A History of Technology, vol. 3, C. Singer, E. J. Holmyard, A. R. Hall, T. I. Williams, Eds. (Clarendon Press), 24 Oct. 1958, 997

Human Dissection, A. M. Lassek (Thomas), 23 Jan. 1959, 204

The Immense Journey, L. Eiseley (Random House), 25 Apr. 1958, 966

The Inner Metagalaxy, H. Shapley (Oxford Univ. Press; Yale Univ. Press), 25 Apr. 1958, 976

Clarence King, T. Wilkins (Macmillan), 21 Nov. 1958, 1271

The Life, Work and Times of Charles Turner Thackrah, Surgeon and Apothecary of Leeds (1795–1833), A. Meiklejohn (Livingstone), 16 May 1958, 1169

On the Magnet, W. Gilbert (Basic Books), 20 Mar. 1959, 773

Man the Maker, R. J. Forbes (Abelard-Schuman), 6 Mar. 1959, 636

The Medical World of the Eighteenth Century, L. S. King (Univ. of Chicago Press), 9 Jan. 1959, 92

Moments of Discovery, vols. 1 and 2, G. Schwartz and P. W. Bishop, Eds. (Basic Books), 20 Feb. 1959, 460

New Bottles for New Wine, J. Huxley (Harper), 8 Aug. 1958, 295

New Knowledge in Human Values, A. H. Maslow, Ed. (Harper), 10 Apr. 1959, 955

Isaac Newton's Papers and Letters on Natural Philosophy and Related Documents, I. B. Cohen, Ed. (Harvard Univ. Press), 19 Dec. 1958, 1566

The Origins of the English Library. R. Irwin (Allen and Unwin), 14 Nov. 1958, 1203

The Origins of Modern Science, 1300–1800, H. Butterfield (Macmillan), 12 Sept. 1958, 589

Personal Knowledge, M. Polanyi (Univ. of Chicago Press), 27 Mar. 1959, 831

Physics and Philosophy, W. Heisenberg; R. N. Anshen, Ed. (Harper), 19 Sept. 1958, 649

A Pictorial History of Science and Engineering, Editors of *Year* (*Year*), 16 May 1958, 1170

The Reach of Science, H. Mehlberg (Univ. of Toronto Press), 31 Oct. 1958, 1078

Relativity for the Layman, J. A. Coleman (New American Library), 16 Jan. 1959, 144

Roots of Scientific Thought, P. P. Wiener and A. Noland, Eds. (Basic Books), 25 Apr. 1958, 973

Science and the Creative Spirit, K. V. Keutsch, F. E. L. Priestley, H. Brown, D. Hawkins; H. Brown, Ed. (Univ. of Toronto Press), 30 May 1958, 1285

Science and Human Life, J. A. V. Butler (Basic Books), 25 Apr. 1958, 972

Science and Human Values, J. Bronowski (Messner), 16 May 1958, 1169

The Shakespearean Ciphers Examined, W. F. Friedman and E. S. Friedman (Cambridge Univ. Press), 25 Apr. 1958, 965

Sherrington, Lord Cohen of Birkenhead (Thomas), 28 Nov. 1958, 1337

A Source Book in Greek Science, M. R. Cohen and I. E. Drabkin (Harvard Univ. Press), 6 Mar. 1959, 635

Space, Time, and Creation, M. K. Munitz (Free Press; Falcon's Wing Press), 5 Sept. 1958, 526

Doctor Squibb, L. G. Blochman (Simon and Schuster), 12 Dec. 1958, 1502

Nicolaus Steno and His Indice, G. Scherz, Ed. (Munksgaard), 7 Nov. 1958, 1132

The Story of Albert Einstein, M. B. Freeman (Random House), 20 June 1958, 1440

The Tao of Science, R. G. H. Siu (Technology Press of MIT; Wiley; Chapman and Hall), 20 June 1958, 1438

D'Arcy Wentworth Thompson, R. D. Thompson (Oxford Univ. Press), 28 Nov. 1958, 1335

Thudichum, Chemist of the Brain, D. L. Drabkin (Univ. of Pennsylvania Press), 14 Nov. 1958, 1202

The Travels of William Bertram, F. Harper (Yale Univ. Press), 18 July 1958, 135

On the Utility of Medical History, I. Galdston, Ed. (International Universities Press), 25 Apr. 1958, 971

Mathematics

Applied Differential Equations, M. R. Spiegel (Prentice-Hall), 8 Aug. 1958, 297
Dynamic Programming, R. Bellman (Princeton Univ. Press), 25 Apr. 1958, 976
Einführung in Theorie und Anwendung der Laplace-Transformation, G. Doetsch (Birkhäuser), 16 Jan. 1959, 145
Figurets, J. A. H. Hunter (Oxford Univ. Press), 11 July 1958, 82
Integral Equations, S. G. Mikhlin (Pergamon), 4 July 1958, 25
Integral Equations, F. G. Tricomi (Interscience), 27 June 1958, 1494
Introduction to Fourier Analysis and Generalised Functions, M. J. Lighthill (Cambridge Univ. Press), 31 Oct. 1958, 1077
An Introduction to Probability Theory and Its Application, W. Feller (Wiley; Chapman and Hall), 10 Apr. 1959, 956
Introduction to Riemann Surfaces, G. Springer (Addison-Wesley), 1 Aug. 1958, 247
An Introduction to the Theory of Integration, A. C. Zaanen (North-Holland; Interscience), 10 Apr. 1959, 957
Logical Design of Digital Computers, M. Phister, Jr. (Wiley; Chapman and Hall), 21 Nov. 1958, 1272
Mathematical Foundations of Information Theory, A. I. Khinchin (Dover), 17 Oct. 1958, 894
Mathematics and Statistics for Use in Pharmacy, Biology and Chemistry, L. Saunders and R. Fleming (Pharmaceutical Press), 5 Dec. 1958, 1427
Philosophy of Mathematics and Natural Science, H. Weyl (Princeton Univ. Press), 20 June 1958, 1440
Puzzle-Math, G. Gamow and M. Stern (Viking), 25 July 1958, 195
Toeplitz Forms and Their Applications, U. Grenander and G. Szego (Univ. of California Press), 18 July 1958, 137

Medicine

Advances in Cancer Research, vol. 5, J. P. Greenstein and A. Haddow, Eds. (Academic Press), 5 Sept. 1958, 528
Advances in Veterinary Science, vol. 4, C. A. Brandly and E. L. Jungherr, Eds. (Academic Press), 12 Dec. 1958, 1501
The Bacteriology of Tuberculosis, E. Darzins (Univ. of Minnesota Press), 18 July 1958, 137
Bone and Radiostrontium, A. Engstrom, R. Björnerstedt, C.-J. Clemedson, A. Nelson (Wiley; Almquist and Wiksell), 19 Sept. 1958, 650
British Pharmacopoeia, 1958, General Medical Council (Pharmaceutical Press), 3 Oct. 1958, 770
The Clinical Application of Antibiotics, vol. 3, M. E. Florey (Oxford Univ. Press), 30 May 1958, 1286
Communicable Diseases, A. L. Bloomfield (Univ. of Chicago Press), 5 Sept. 1958, 529
Cunningham's Manual of Practical Anatomy, vol. 1, J. C. Brash (Oxford Univ. Press), 29 Aug. 1958, 468

The Extra Pharmacopoeia, vol. 1, Council of the Pharmaceutical Soc. of Great Britain (Pharmaceutical Press), 17 Oct. 1958, 894

General Diagnosis and Therapy of Skin Diseases, H. W. Siemens (Univ. of Chicago Press), 4 July 1958, 24

German-English Glossary of Neurophysiology, R. M. Morrell, Ed. (Consultants Bureau), 25 Apr. 1958, 969

Hospital Treatment of Alcoholism, R. S. Wallerstein *et al.* (Basic Books), 27 June 1958, 1494

Human Infertility, C. L. Buxton and A. L. Southern (Harper), 8 Aug. 1958, 298

Human Protein Requirements and Their Fulfillment in Practice, J. C. Waterlow and J. M. L. Stephen, Eds. (Wright), 6 June 1958, 1333

An Introduction to Medical Mycology, G. M. Lewis, M. E. Hopper, J. W. Wilson, O. A. Plunkett (Year Book), 5 Dec. 1958, 1428

The Mammalian Cerebral Cortex, B. D. Burns (Arnold), 14 Nov. 1958, 1201

Medical Education (World Health Organization), 3 Apr. 1959, 891

The Motility of Muscle and Cells, H. H. Weber (Harvard Univ. Press), 3 Oct. 1958, 768

Pharmacologic Principles of Medical Practice, J. C. Krantz, Jr., and C. J. Carr (Williams and Wilkins), 2 May 1958, 1041

Pharmacology in Medicine, V. A. Drill, Ed. (McGraw-Hill), 4 July 1958, 24

The Practice of Sanitation, E. S. Hopkins and W. H. Schulze (Williams and Wilkins), 6 Mar. 1959, 634

Problema Protivorakovikh Antibiotikov, N. G. Klueva and G. I. Roskin (Tarasevicha), 25 July 1958, 195

Radiation Biology and Medicine, W. D. Claus, Ed. (Addison-Wesley), 27 Feb. 1959, 558

Sewerage and Sewage Treatment, H. E. Babbitt and E. R. Baumann (Wiley; Chapman and Hall), 13 Mar. 1959, 714

Surface and Radiological Anatomy, ed. 4, by W. J. Hamilton and G. Simon (Heffer), 10 Apr. 1959, 955

Textbook of Virology for Students and Practitioners of Medicine, A. J. Rhodes and C. E. Van Rooyen (Williams and Wilkins), 9 Jan. 1959, 92

The Tissues of the Body, W. E. LeG. Clark (Oxford Univ. Press), 21 Nov. 1958, 1273

Veterinary Toxicology, R. J. Garner (Bailliere, Tindall and Cox), 25 Apr. 1958, 971

Vitamin A, T. Moore (Elsevier), 25 Apr. 1958, 968

Physics

Annual Review of Nuclear Science, vol. 7, J. G. Beckerley, Ed. (Annual Reviews), 25 Apr. 1958, 975

Applied Optics and Optical Design, A. E. Conrady (Dover), 18 July 1958, 136

Concepts of Classical Optics, J. Strong (Freeman), 31 Oct. 1958, 1077

The Effects of Radiation on Materials, J. J. Harwood, H. H. Hausner, J. G. Morse, W. G. Rauch, Eds. (Reinhold; Chapman and Hall), 30 Jan. 1959, 265

Electric Conduction in Semiconductors

and Metals, W. Ehrenberg (Oxford Univ. Press), 3 Apr. 1959, 892

Electrical Discharges in Gases, F. M. Penning (Macmillan; Philips' Technical Library), 5 Dec. 1958, 1426

Electron Impact Phenomena, G. H. Field and J. L. Franklin (Academic Press), 16 May 1958, 1171

Elementary Statistical Physics, C. Kittel (Wiley; Chapman and Hall), 28 Nov. 1958, 1336

Elementary Theory of Angular Momentum, M. E. Rose (Wiley; Chapman and Hall), 25 Apr. 1958, 976

Foundations of Modern Physical Science, G. Holton and D. H. D. Roller (Addison-Wesley), 20 Mar. 1959, 771

Fundamentals of Physics, H. Semat (Rinehart), 13 June 1958, 1385

A Handbook of Lattice Spacings and Structures of Metals and Alloys, W. B. Pearson (Pergamon), 24 Oct. 1958, 1000

Handbuch der Physik, S. Flügge, Ed. (Springer), vol. 5, *Principles of Quantum Theory,* 3 Oct. 1958, 769; vol. 16, *Electric Fields and Waves,* 4 July 1958, 25; vol. 34, *Corpuscles and Radiation in Matter,* 26 Sept. 1958, 710; vol. 38, pt. 1, *External Properties of Atomic Nuclei,* 13 Mar. 1959, 713; vol. 45, *Nuclear Instrumentation, II,* 6 Feb. 1959, 325; vol. 50, *Astrophysics, I,* 5 Sept. 1958, 528

Heat Transfer, vol. 2, M. Jakob (Wiley; Chapman and Hall), 17 Oct. 1958, 893

Introduction to Modern Physics, C. H. Blanchard, C. R. Burnett, R. C. Stoner, R. L. Weber (Prentice-Hall), 20 Mar. 1959, 771

Ionographie, P. Demers (Univ. of Montreal Press), 24 Oct. 1958, 998

Lectures on Nuclear Theory, C. Landau and Y. Smorodinsky (Consultants Bureau; State Technical-Theoretical Literature Press, Moscow), 27 June 1958, 1495

Light, Color and Vision, Y. Le Grand (Wiley), 27 June 1958, 1495

Man's World of Sound, J. R. Pierce and E. E. David, Jr. (Doubleday), 13 Feb. 1959, 383

Mass Spectroscopy, H. E. Duckworth (Cambridge Univ. Press), 29 Aug. 1958, 468

The Measurement of Colour, W. D. Wright (Macmillan), 12 Sept. 1958, 588

Nuclear Structure, L. Eisenbud and E. P. Wigner (Princeton Univ. Press), 22 Aug. 1958, 409

Physico-Chemical Effects of Pressure, S. D. Hamann (Academic Press; Butterworth), 27 June 1958, 1496

Physics, E. Hausmann and E. P. Slack (Van Nostrand), 13 June 1958, 1385

Physics, H. Semat and R. Katz (Rinehart), 20 Mar. 1959, 771

Physics, O. M. Stewart (Ginn), 13 June 1958, 1385

The Physics of Elementary Particles, J. D. Jackson (Princeton Univ. Press), 3 Apr. 1959, 891

Physics for Engineers and Scientists, R. G. Fowler and D. I. Meyer (Allyn and Bacon), 20 Mar. 1959, 771

Physics of Fission, S. M. Popova, Ed. (Consultants Bureau), 15 Aug. 1958, 353

Physics of Nuclear Fission, Translated by J. E. S. Bradley (Pergamon), 5 Dec. 1958, 1427

Physique électronique des gaz et des solides, M. Bayet (Masson), 12 Sept. 1958, 589

Principles of Modern Physics, A. P. French (Wiley; Chapman and Hall), 20 Mar. 1959, 771

Proceedings of the International Symposium on Isotope Separation, J. Kistemaker, J. Bigeleisen, A. O. C. Nier, Eds. (North-Holland; Interscience), 3 Oct. 1958, 769

Proceedings of the Rehovoth Conference on Nuclear Structure, H. J. Lipkin, Ed. (North-Holland; Interscience), 25 July 1958, 195

Progress in Nuclear Physics, vol. 6, O. R. Frisch, Ed. (Pergamon), 25 Apr. 1958, 975

Quantum Mechanics, vol. 3, L. D. Landau and E. M. Lifshitz (Pergamon; Addison Wesley), 3 Oct. 1958, 767

Quantum Mechanics of One- and Two-Electron Atoms, H. A. Bethe and E. E. Salpeter (Springer; Academic Press), 19 Dec. 1958, 1567

Radiological Physics, M. E. J. Young (Academic Press), 25 Apr. 1958, 977

Russian-English Glossary of Electronics and Physics (Consultants Bureau), 25 Apr. 1958, 977

Russian-English Glossary of Nuclear Physics and Engineering (Consultants Bureau), 25 Apr. 1958, 977

Russian-English Glossary of Solid State Physics (Consultants Bureau), 25 Apr. 1958, 977

Shell Theory of the Nucleus, E. Feenberg (Princeton Univ. Press), 5 Sept. 1958, 528

Solid State Physics, vol. 6, F. Seitz and D. Turnbull, Eds. (Academic Press), 9 Jan. 1959, 91

Psychology

De l'actinie à l'homme, vol. 1, H. Pieron (Presses Universitaire de France), 31 Oct. 1958, 1079

Aggression, J. P. Scott (Univ. of Chicago Press), 26 Sept. 1958, 708

Animal Behavior, J. P. Scott (Univ. of Chicago Press), 16 May 1958, 1170

Behavior and Evolution, A. Roe and G. G. Simpson (Yale Univ. Press), 23 Jan. 1959, 203

The Brain and Human Behavior, Assoc. for Research in Nervous and Mental Disease (Williams and Wilkins), 5 Dec. 1958, 1427

The Central Nervous System and Behavior, M. A. B. Brazier, Ed. (Josiah Macy Jr. Foundation), 3 Apr. 1959, 892

A Comprehensive Dictionary of Psychological and Psychoanalytical Terms, H. B. English and A. English (Longmans, Green), 1 Aug. 1958, 247

Current Concepts of Positive Mental Health, M. Jahoda (Basic Books), 30 Jan. 1959, 265

Current Trends in the Description and Analysis of Behavior, R. Glaser *et al.* (Univ. of Pittsburgh Press), 12 Dec. 1958, 1501

Discussions on Child Develpoment, vol. 3, J. M. Tanner and B. Inhelder, Eds. (International Universities Press), 6 Feb. 1959, 324

Dynamics of Behavior, R. S. Woodworth (Holt), 29 Aug. 1958, 468

Economics of Mental Illness, R. Fein (Basic Books), 6 Feb. 1959, 325

Electronic Instrumentation for the Behavioral Sciences, C. C. Brown and R. T. Saucer (Thomas), 24 Oct. 1958, 999

The Growth of Logical Thinking from Childhood to Adolescence, B. Inhelder and J. Piaget (Basic Books), 27 June 1958, 1496

Instinctive Behavior, C. H. Schiller, Ed. (International Universities Press), 9 May 1958, 1112

International Directory of Psychologists Exclusive of the U.S.A., E. H. Jacobson, Ed. (Natl. Acad. of Science–Natl. Research Council), 27 Mar. 1959, 834

An Introduction to Method in Psychology, W. M. O'Neil (Melbourne Univ. Press), 25 Apr. 1958, 982

Selected Writings of John Hughlings Jackson, vols. 1 and 2, J. Taylor, Ed. (Basic Books), 14 Nov. 1958, 1203

The Measurement and Appraisal of Adult Intelligence, D. Wechsler (Williams and Wilkins), 7 Nov. 1958, 1133

Mental Subnormality, R. L. Masland, S. B. Sarason, T. Gladwin (Basic Books), 20 Mar. 1959, 772

The Motivation, Productivity, and Satisfaction of Workers, A. Zaleznik, C. R. Christensen, F. J. Roethlisberger, G. C. Homans (Harvard Univ. Press), 6 Mar. 1959, 633

Patients, Physicians, and Illness, E. G. Jaco, Ed. (Free Press), 6 Mar. 1959, 634

Perception and Communication, D. E.

Broadbent (Pergamon), 3 Apr. 1959, 893

Physiological Bases of Psychiatry, pts. 1 and 2, W. H. Gantt, Ed. (Thomas), 27 Feb. 1959, 559

Principles of Perception, S. H. Bartley (Harper), 25 Apr. 1958, 979

Psychological Stress, I. L. Janis (Wiley; Chapman and Hall), 20 Feb. 1959, 459

Psychology, Evolution and Sex, C. P. Martin (Thomas), 9 May 1958, 1111

Psychotropic Drugs, S. Garattini and V. Ghetti, Eds. (Elsevier), 18 July 1958, 136

The Senses, W. von Buddenbrock (Univ. of Michigan Press), 17 Oct. 1958, 894

Social Class and Mental Illness, A. B. Hollingshead and F. C. Redlich (Wiley; Chapman and Hall), 22 Aug. 1958, 411

Some Applications of Behavioural Research, R. Likert and S. P. Hayes, Jr., Eds. (UNESCO), 8 Aug. 1958, 295

The Testing of Negro Intelligence, A. M. Shuey (Bell), 8 Aug. 1958, 297

Theory and Methods of Scaling, W. S. Torgerson (Wiley; Chapman and Hall), 27 Feb. 1959, 560

Thinking, F. Bartlett (Basic Books), 21 Nov. 1958, 1273

Verbal Behavior, B. F. Skinner (Appleton-Century-Crofts), 16 Jan. 1959, 143

Public Affairs

The Academic Mind, P. Lazarsfeld and W. Thielens, Jr. (Free Press), 2 Jan. 1959, 34

The Administrative State, F. M. Marx (Univ. of Chicago Press), 25 Apr. 1958, 981

Admission Requirements of American Medical Colleges, Including Canada, 1958–59, H. H. Gee and E. S. Nourse (Assoc. of American Medical Colleges), 26 Sept. 1958, 711

Advances in Documentation and Library Science, vol. 1, G. L. Peakes, A. Kent, J. W. Perry, Eds.; vol. 2, J. H. Shera, A. Kent, J. W. Perry, Eds. (Interscience), 25 Apr. 1958, 967

Algeria, G. Tillion (Knopf), 10 Oct. 1958, 835

The American High School Today, J. B. Conant (McGraw-Hill), 13 Feb. 1959, 382

The American Idea of Mission, E. M. Burns (Rutgers Univ. Press), 6 June 1958, 1334

American Voting Behavior, E. Burdick and A. J. Brodbeck, Eds. (Free Press), 17 Apr. 1959, 1019

Behavioral Goals of General Education in High Schools, W. French *et al.* (Russell Sage Foundation), 16 May 1958, 1171

Changing Values in College, P. E. Jacob (Harper), 25 Apr. 1958, 981

College Teaching by Television, J. C. Adams, C. R. Carpenter, D. R. Smith, Eds. (American Council on Education), 6 Mar. 1959, 633

Colleges for Our Land and Time, E. D. Eddy, Jr. (Harpers), 25 Apr. 1958, 964

Education and Freedom, H. G. Rickover (Dutton), 20 Mar. 1959, 771

Environmental Sanitation, J. A. Salvato, Jr. (Wiley; Chapman and Hall), 30 Jan. 1959, 265

An Essay on Quality in Public Education, Educational Policies Commission

(Natl. Education Assoc. of the U.S.), 13 Feb. 1959, 382

Explorations in Role Analysis: Studies of the School Superintendency Role, N. Gross, W. S. Mason, A. W. McEachern (Wiley), 25 Apr. 1958, 979

Fellowships in the Arts and Sciences, 1959–60, V. B. Potter (Univ. of Wisconsin Press), 13 Mar. 1959, 715

Frontiers of Science, L. Poole (McGraw-Hill), 19 Sept. 1958, 650

Guide to Russian Medical Literature, S. Adams and F. B. Rogers, Eds. (Natl. Library of Medicine), 19 Dec. 1958, 1567

How to Estimate the Building Needs of a College or University, W. T. Middlebrook (Univ. of Minnesota Press), 1 Aug. 1958, 248

Information Indexing and Subject Cataloging: Alphabetic: Classified: Coordinate: Mechanical, J. Metcalfe (Scarecrow Press), 28 Nov. 1958, 1336

Inspection for Disarmament, S. Melman, Ed. (Columbia Univ. Press), 1 Aug. 1958, 245

Land, the Yearbook of Agriculture, 1958, U.S. Department of Agriculture (Government Printing Office), 9 Jan. 1959, 91

The Liberal Arts College, G. P. Schmidt (Rutgers Univ. Press), 25 Apr. 1958, 966

L.L.U. Translations Bulletin (Dept. of Scientific and Industrial Research, London), 27 Feb. 1959, 562

Loyalty and Security, R. S. Brown, Jr. (Yale Univ. Press), 12 Sept. 1958, 587

Mechanical Resolution of Linguistic Problems, A. D. Booth, L. Brandwood, J. P. Cleave (Academic Press; Butterworths), 30 May 1958, 1284

Mirror to Physiology, R. W. Gerard (American Physiological Soc.), 16 Jan. 1959, 144

The New India, Indian Planning Commission (Macmillan), 13 June 1958, 1386

No More War! L. Pauling (Dodd, Mead), 15 Aug. 1958, 352

On Nuclear Energy, D. J. Hughes (Harvard Univ. Press), 25 Apr. 1958, 974

Our Nuclear Future, E. Teller and A. L. Latter (Criterion Books), 2 May 1958, 1042

Particulate Clouds: Dusts, Smokes, and Mists, H. L. Green and W. R. Lane (Van Nostrand), 21 Nov. 1958, 1271

Peace without Victory, L. W. Martin (Yale Univ. Press), 13 Mar. 1959, 713

Principles of Economic Policy, K. E. Boulding (Prentice-Hall), 25 Apr. 1958, 980

The Problem of Scientific and Technical Manpower in Western Europe, Canada and the United States (Organisation for European Economic Co-operation), 11 July 1958, 82

Project Satellite, K. W. Gatland, Ed. (British Book Center), 6 Mar. 1959, 636

Project Sherwood, A. Bishop (Addison-Wesley), 27 Feb. 1959, 558

The Public Impact of Science in the Mass Media (Inst. for Social Research, Univ. of Michigan), 20 Feb. 1959, 458

Publications of the World Health Organization, 1947–1957 (World Health Organization), 28 Nov. 1958, 1338

Russia, the Atom and the West, G. F. Kennan (Harper), 6 June 1958, 1332

Science and Education at the Crossroads, J. W. Still (Public Affairs Press), 20 Feb. 1959, 459

Science, the News, and the Public, H. Krieghbaum (New York Univ. Press), 20 Feb. 1959, 458

Science in Schools, W. H. Perkins, Ed. (Butterworths), 7 Nov. 1958, 1132

Scientific Manpower in Europe, E. McCrensky (Pergamon), 27 Feb. 1959, 561

Scientific Societies in the United States, R. S. Bates (Technology Press; Columbia Univ. Press), 31 Oct. 1958, 1078

Scientists' Choice, F. M. Branley Ed. (Basic Books), 16 Jan. 1959, 144

Six Days or Forever? Tennessee vs. John Thomas Scopes, R. Ginger (Beacon Press), 3 Oct. 1958, 768

Solving the Scientist Shortage, D. C. Greenwood (Public Affairs Press), 6 Feb. 1959, 323

Sorok Let Sovetskovo Zdravookhraneniya, 1917–1957, Ministry of Health Protection, U.S.S.R. (Medgiz), 13 June 1958, 1384

Space Book for Young People, H. E. Newell, Jr. (McGraw-Hill), 19 Sept. 1958, 650

The Space Child's Mother Goose, F. Winsor (Simon and Schuster), 25 Apr. 1958, 965

Strategic Surrender, P. Kecskemeti (Stanford Univ. Press), 15 Aug. 1958, 354

The Teaching of Hygiene and Public Health in Europe, F. Grundy and J. M. Mackintosh (World Health Organization), 25 Apr. 1958, 981

UNESCO, W. H. C. Laves and C. A. Thomson (Indiana Univ. Press), 25 Apr. 1958, 967

U.S. Research Reactor Operation and Use, J. W. Chastain, Jr., Ed. (Addison-Wesley), 27 Feb. 1959, 558

What's Happened to Our High Schools?, J. F. Latimer (Public Affairs Press), 9 May 1958, 1110

World of Learning, 1958–59 (Europa), 10 Apr. 1959, 958

Year of Crisis, E. M. Kirkpatrick, Ed. (Macmillan), 25 Apr. 1958, 978

Yearbook of International Organizations, 1958–59 (Union of International Associations), 2 Jan. 1959, 37

Young People's Book of Science, G. O Blough, Ed. (McGraw-Hill), 19 Sept. 1958, 650

Social Sciences

Abortion in the United States, M. S. Calderone, Ed. (Hoeber-Harper), 2 Jan. 1959, 36

The American Labor Force: Its Growth and Changing Composition, G. Bancroft (Wiley; Chapman and Hall), 20 Mar. 1959, 773

Ancient Man in North America, H. M. Wormington (Denver Museum of Natural History), 11 July 1958, 81

An Anthropologist at Work, M. Mead (Houghton Mifflin), 6 Feb. 1959, 322

From Ape to Angel, H. R. Hays (Knopf), 31 Oct. 1958, 1077

Asian Perspectives, vol. 1, W. Solheim, II, Ed. (Univ. of Arizona Press), 1 Aug. 1958, 247

Coral Island, Portrait of an Atoll, M. Bates and D. P. Abbott (Scribner's), 7 Nov. 1958, 1132

The Scope of Physical Anthropology and Its Place in Academic Studies, D. F. Roberts and J. S. Weiner, Eds. (Wenner-Gren Foundation for Anthropological Research, Inc.), 13 Feb. 1959, 383

. . . In Search of Identity, J. W. Bennett, H. Passin, R. K. McKnight (Univ. of Minnesota Press), 10 Apr. 1959, 955

Social Mechanisms, G. Karlsson (Free Press), 23 Jan. 1959, 205

Soils for the Archaeologist, I. W. Cornwall (Macmillan), 23 Jan. 1959, 205

The Story of Archaeology, A. Allen (Philosophical Library), 14 Nov. 1958, 1203

The Story of Life, H. E. L. Mellersh (Putnam's), 23 May 1958, 1235

Sun Circles and Human Hands, E. L. Fundaburk and M. D. F. Foreman, Eds. (Fundaburk), 4 July 1958, 23

Talent and Society, D. C. McClelland, A. L. Baldwin, U. Bronfenbrenner, F. L. Strodtbeck (Van Nostrand), 10 Oct. 1958, 832

Traité de paléontologie, vol. 7, J, Piveteau (Masson), 25 Apr. 1958, 979

The Transvaal Ape-Man — Bearing Cave Deposits, C. K. Brain (Transvaal Museum), 10 Apr. 1959, 957

Tribes That Slumber, T. M. N. Lewis and M. Kneberg (Univ. of Tennessee Press), 23 Jan. 1959, 204

Wind and Solar Energy (UNESCO), 1 Aug. 1958, 247

Technology

Basic Facts on Productivity Change, S. Fabricant (Natl. Bureau of Economic Research, Inc.), 3 Apr. 1959, 890

Bibliography of Food, E. A. Baker and D. J. Foskett (Academic Press; Butterworths), 14 Nov. 1958, 1202

Boiling Water Reactors, A. W. Kramer (Addison-Wesley, 27 Feb. 1959, 558

Bridges and Their Builders, D. B. Steinman and S. R. Watson (Dover), 5 Sept. 1958, 529

Chemical Engineering in the Coal Industry, F. W. Sharpley, Ed. (Pergamon), 2 May 1958, 1042

Einführung in die Messtechnik der Kernstrahlung und die Anwendung der Radioisotope, H. Fassbender (Thieme), 24 Oct. 1958, 1000

Elements of Water Supply and Waste-Water Disposal, G. M. Fair and J. C. Geyer (Wiley; Chapman and Hall), 12 Sept. 1958, 589

Energy for Man, H. Thirring (Indiana Univ. Press), 14 Nov. 1958, 1201

Engineering Manpower, How to Improve Its Productivity, Graduate School of Business Administration, Harvard Univ. (Engineering Managements Reports), 25 Apr. 1958, 966

Flavor Research and Food Acceptance (Reinhold; Chapman and Hall), 27 Mar. 1959, 834

Fluid Fuel Reactors, J. A. Lane, H. G. MacPherson, F. Maslan (Addison-Wesley), 27 Feb. 1959, 558

Fundamentals of Advanced Missiles, R. B. Dow, (Wiley; Chapman and Hall), 17 Apr. 1959, 1020

The Future Supply of Oil and Gas, B. C. Netschert (Johns Hopkins Univ. Press), 25 July 1958, 196

The Industrial Challenge of Nuclear

Energy (Organisation for European Economic Co-operation), 22 Aug. 1958, 410

Physik und Technik der Atomreaktoren, F. Cap (Springer), 29 Aug. 1958, 470

Plant Design and Economics for Chemical Engineers, M. S. Peters (McGraw-Hill), 24 Oct. 1958, 1000

Punched Cards, R. S. Casey, J. W. Perry, M. M. Berry, A. Kent, Eds. (Reinhold; Chapman and Hall), 27 Feb. 1959, 562

Oil: From Prospect to Pipeline, R. R. Wheeler and M. Whited (Gulf Publishing Co.), 19 Sept. 1958, 651

Queues, Inventories and Maintenance, P. M. Morse (Wiley; Chapman and Hall), 7 Nov. 1958, 1130

Safety Techniques for Radioactive Tracers, J. C. Boursnell (Cambridge Univ. Press), 7 Nov. 1958, 1132

The Shippingport Pressurized Water Reactor, U.S. Atomic Energy Commission, Westinghouse Electric Corp., and Duquesne Light Company (Addison-Wesley), 27 Feb. 1959, 558

Sodium Graphite Reactors, C. Starr and R. W. Dickinson (Addison-Wesley), 27 Feb. 1959, 558

Solid Fuel Reactors, J. R. Dietrich and W. H. Zinn (Addison-Wesley), 27 Feb. 1959, 558

Soviet Research in Glass and Ceramics, Chemistry collection No. 2 (Consultants Bureau), 25 Apr. 1958, 974

Surface Active Agents and Detergents, vol. 2, A. M. Schwartz, J. W. Perry, J. Berch (Interscience), 21 Nov. 1958, 1272

Textile Chemicals and Auxiliaries, H. C. Speel and E. W. K. Schwarz (Reinhold; Chapman and Hall), 5 Sept. 1958, 528

Thorium Production Technology, F. L. Cuthbert (Addison-Wesley), 27 Feb. 1959, 558

Uranium Ore Processing, J. W. Clegg and D. D. Foley, Eds. (Addison-Wesley), 27 Feb. 1959, 558

Zoological Sciences

Annual Review of Entomology, vol. 3, E. A. Steinhaus, Ed. (Annual Reviews), 18 July 1958, 136

The Beginnings of Embryonic Development, A. Tyler, R. C. von Borstel, C. B. Metz, Eds. (AAAS), 16 May 1958, 1170

Bird Hybrids, A. P. Gray (Commonwealth Agricultural Bureaux), 23 Jan. 1959, 206

Extinct and Vanishing Birds of the World, J. C. Greenway, Jr. (American Committee for International Wild Life Protection), 23 Jan. 1959, 206

The Faunal Connections between Europe and North America, C. H. Lindroth (Wiley; Almquist and Wiksell), 2 May 1958, 1043

A Field Guide to Reptiles and Amphibians of Eastern North America, R. Conant (Houghton Mifflin), 26 Dec. 1958, 1620

The Fishes of Ohio, M. B. Trautman (Ohio State Univ. Press), 2 May 1958, 1044

General Zoology, G. B. Moment (Houghton Mifflin), 17 Oct. 1958, 893

General Zoology, C. A. Villee, W. F. Walker, Jr., F. E. Smith (Saunders), 17 Oct. 1958, 893

Georgia Birds, T. D. Burleigh (Univ. of Oklahoma Press), 23 Jan. 1959, 206

The Handbook of Feedstuffs, R. Seiden and W. H. Pfander (Springer), 11 July 1958, 83

Insect Migration, C. B. Williams (Macmillan), 23 Jan. 1959, 205

The Invertebrata, L. S. Borradaile and F. A. Potts, revised by G. A. Kerkut (Cambridge Univ. Press), 11 July 1958, 81

The Life of Mammals, J. Z. Young (Oxford Univ. Press), 25 Apr. 1958, 970

Listening in the Dark, D. R. Griffin (Yale Univ. Press), 3 Oct. 1958, 766

Marine Ecology, H. B. Moore (Wiley; Chapman and Hall), 30 Jan. 1959, 264

Palmer's Fieldbook of Mammals, E. L. Palmer (Dutton), 30 May 1958, 1285

The Physiology of Fishes, vol. 2, M. E. Brown, Ed. (Academic Press), 25 Apr. 1958, 970

Snakes in Fact and Fiction, J. A. Oliver (Macmillan), 22 Aug. 1958, 412

Studies on Fossil Vertebrates, T. S. Westoll, Ed. (Athlone Press; Essential Books), 3 Oct. 1958, 767

Systema Helminthum, S. Yamaguti (Interscience), 10 Apr. 1959, 956

Traité de paléontologie, vol. 2, J. Piveteau, Ed. (Masson), 17 Apr. 1959, 1020

Zoogeography, C. L. Hubbs, Ed. (AAAS), 17 Apr. 1959, 1018

Zoogeography: the Geographical Distribution of Animals, P. J. Darlington, Jr. (Wiley), 25 Apr. 1958, 969

Letters

Keynes' Model

The article by David McCord Wright, "Mr. Keynes and the 'Day of Judgment'" [*Science* **128**, 1258 (1958)], seemed to me to distort in several important respects Keynes' model of the operation of the economy and its impact on economic theorizing and policy making in the past 25 years.

Wright criticizes Keynes for assuming in his model that resources, population, tastes, and technology are constant. He interprets this to mean that Keynes was ignoring all the dynamic forces which are usually considered vital to a free enterprise system. But Keynes began by specifically disavowing two other static assumptions which classical theory, from Adam Smith on, had always included. This body of theory, which was the theoretical genesis of *laissez faire* capitalism, assumed Say's law of markets, which prevented a condition of general overproduction, and full employment, which would always prevail provided that wages were suitably adjusted. Both these suppositions were clearly untenable in the environment of the 1930's, and Keynes' theory, far from including more static forces, included fewer. In economic theory, dynamics means simply that variables can be dated and their equilibrium path traced. It was the impact of the Keynesian model on economics which made the development of economic dynamics possible, as epitomized in the work of J. R. Hicks, Samuelson, Lawrence Klein, Roy Harrod, and others. Harrod's "Relation," mentioned critically by Wright, is in fact a major tool of dynamic economics. It is scarcely fair to criticize Keynes for being static when all economics had been static until his time and when his theory, though at best a comparative static model, paved the way for contemporary economic dynamics.

It is in his discussion of investment, however, that it seems to me Wright most seriously distorts Keynes. It is permissible to "scrape all the verbiage off Keynes' model" provided one doesn't scrape off crucial elements of the theory. Wright insists that Keynes made investment depend exclusively on consumption, and he notes that inasmuch as Keynes postulated that consumption would not increase as fast as income, a "day of judgment," involving an overproduction crisis, was inevitable. It is true that Keynes postulated this relationship of consumption to income within his static equilibrium model, but income is determined by investment quite as much as by consumption (indeed, in the Keynesian system, cycles are generated by fluctuations in invest-

ment far more than by fluctuations in consumption, which Keynes felt was quite stable). Only in the sense that all economic activity is ultimately directed at satisfying consumer wants is it correct to state that investment depends on consumption. In his system, Keynes made investment a function of the interest rate and of the marginal efficiency of capital (his term for the rate of profit which the business community expected on the next contemplated unit of investment). So long as the businessmen expect the economy to grow (thus reflecting their estimation of the "dynamic social forces" that Wright insists are ignored by Keynes), there is no reason why they should not continue to expand investment. And so long as the economy is growing, there is no reason why the monetary authorities should raise interest rates (to prevent inflation). On the other hand, there is no reason why, if the business community does have reasonably high profit expectations, the interest rate should fall so low that no one is willing to lend.

Thus, Keynes' model is not itself gloomy at all. Keynes' immediate purpose was to explain the gloomy state of affairs he saw around him in England and the United States. But within the framework of his model, one can analyze with equal cogency "underemployment equilibrium" and "overemployment equilibrium." The inflationary gap can be explained as well as the deflationary gap.

Keynes, in short, did not concentrate on consumption to the exclusion of investment—quite the reverse. His theory has led to greater progress in "dynamizing" economic theory than was ever made before. His theory was profoundly procapitalist and antisocialist in the sense that he was pointing the way to the development of public policy which might vitiate the "internal contradictions of capitalism" constantly emphasized by the Marxists.

PHILIP A. KLEIN
*Department of Economics,
Pennsylvania State University*

Most of Klein's criticisms would, I believe, be cleared up by a careful rereading of my article. Let me, however, be more specific.

Klein is apparently unwilling to follow me in clearly distinguishing between Keynes' model and the extent to which Keynes was willing to apply it. The model, I submit, is just as rigid and as gloomy as I stated. Anyone who doubts this can read chapter 24 of the *General Theory,* to which Klein, for some reason, does not refer.

I tried hard in my article to show that Keynes did not always apply his model literally, and that therefore his thought

was often more dynamic than is usually supposed. This is particularly evident from Keynes' approval of my "Future of Keynesian economics" article [*Am. Econ. Rev.* (June 1945)], which Klein does not seem to have read. I feel sure that were Keynes alive today he would be the first to repudiate much of what is now written in his name. On the other hand, Keynes undoubtedly did write, also, a great deal of nonsense. But to be scientists we have to distinguish between the model and the man.

The rest of Klein's letter contains an extraordinary collection of errors concerning the history of economic thought. Adam Smith had a rudimentary business-cycle theory. It is almost unbelievable to me that anyone could say that "all economics had been static" before Keynes' time. What about Sir Dennis Robertson, whom Keynes called his "father," or Irving Fisher, or Aftalion, or Wicksell?

Nearly every modern authority now admits that a sufficient wage cut would give full employment. Keynes, indeed, with typical inconsistency, said so himself.

DAVID MCCORD WRIGHT
Department of Economics and Political Science, McGill University

Who Should Teach English?

With most of the suggestions of T. R. Henn ["Literature in a technological age," *Science* **128**, 1325 (1958)] I am in hearty agreement. But when Henn writes that "the teaching of English . . . should be done wherever possible by the science teachers themselves," I begin to disagree, unless he is willing to place special emphasis upon the qualification "wherever possible." How many and where are the science teachers in colleges and universities who can either meet or teach the writing standards Henn sets up for scientists?

Persons untrained in the teaching of English, rhetoric, or writing (call it what you will) are apt to insist upon their personal, and sometimes silly, preferences. Often these preferences are based upon imperfect understanding of such writing fundamentals as they picked up, somewhat against their will, as they dashed or slumbered through English classes. Only a few days ago I heard of a university teacher of entomology who was insisting to his graduate students that they should not use nouns as adjectives. I don't know what the gentleman says when he wants to discuss house flies or horse flies.

JAMES S. AYARS
State Natural History Survey, Urbana, Illinois

Meetings

Quantitative Biology

The 24th Cold Spring Harbor Symposium on Quantitative Biology will be held 3–10 June. The topic of the meetings will be "Genetics and 20th Century Mendelism," and geneticists, anthropologists, and paleontologists will participate in the program. Individual sessions will deal with the theory of the gene and raw materials of evolution, natural selection and race formation, ecological systems and social organization, isolating mechanisms and speciation, the fossil record and rates of evolution, and trends of evolution.

The symposium is open to all who are interested, but because of space limitations it is important to make advance reservations. For program and information address the Biological Laboratory, Cold Spring Harbor, N.Y.

Information Processing

The First International Conference on Information Processing is to be held in Paris, 13–22 June. The conference is being organized by the United Nations Educational, Scientific and Cultural Organization with the help of a number of consultants representing the United States, France, Sweden, Italy, Belgium, Russia, West Germany, the Netherlands, the United Kingdom, and Japan. The United States Committee for the International Conference on Information Processing—representing the Institute of Radio Engineers, the Association for Computing Machinery, and the American Institute of Electrical Engineers—will coordinate American participation in the meeting.

The formal program of the conference will include some 60 technical papers in six major areas: methods of digital computing; logical design of digital computers; common symbolic language for digital computers; automatic translation of languages; collection, storage, and retrieval of information; and pattern recognition and machine learning.

These topics will be covered in 11 3-hour plenary sessions in the new UNESCO Palace from 15 June through 20 June. A general rapporteur will present an introductory discussion on each of the six main subjects. There will be simultaneous oral translation of the technical papers into English, French, Russian, Spanish, and German. Comments from the floor will be invited, and the published conference proceedings will contain the entire text of the papers and the discussion from the floor, provided the latter is also submitted in writing. All abstracts and preprints will be mailed to officially registered conference participants.

Conference events will also include symposia, oral surveys on the status of information processing in each country, and an international exhibition of data processing equipment. Technical descriptions of such equipment will be scheduled in conjunction with the exhibits.

Some 1500 specialists will attend the conference, which is expected to lead to creation of an international organization to plan future conferences and to aid in international exchange of information in the field. For conference details, write to: United States Committee for the International Conference on Information Processing, Box 4999, Washington 8, D.C.

Quantum Electronics

An International Conference on Quantum Electronics—Resonance Phenomena will be held at the Shawanga Lodge, Bloomingburg, N.Y., 14–16 September. The conference will consider basic problems in physics and electronics that are important to the increasing use of molecular and atomic resonances in masers, atomic clocks, and related devices, as well as the application of quantum electronics to scientific problems.

It is intended that this will be a working conference rather than a tutorial meeting. Consequently, attendance is being limited to those who are active in appropriate fields of research. For information, write to I. Rowe, Scientific Department, Office of Naval Research, 346 Broadway, New York 13, N.Y.

Education of the Scientist

A conference on The Education of the Scientist in a Free Society will be held at Marquette University, 20–22 May, as part of the 50th anniversary celebration of Marquette's College of Engineering. The speakers will include: Edward Teller, University of California, "What is Scientific Education?—The Problem Today"; Senator Paul Douglas, Illinois, "What Does Free Society Demand of the Scientifically Educated?", and Frederic Lindvall, California Institute of Technology, "On the Nature of an Engineer."

Arid Lands Research

The Spanish Government will be host to UNESCO's Symposium on the Water Relations of Plants in Arid and Semi-Arid Zones, which will take place in Madrid, 24–30 September. As part of UNESCO's arid-lands program, symposia bearing on subjects directly related to the fields of arid-zone research are or-

ganized each year with the assistance of different member states.

In addiiton to its own specialists, the Spanish Government proposes to invite various foreign scientists to attend, while UNESCO will arrange for the participation of a number of experts, particularly from North Africa, the Middle East, and South Asia. It is hoped that certain specialists will also be able to attend at their own expense or at the expense of the institutions for which they work. The total number of participants will not exceed 60.

The UNESCO Department of Natural Sciences, Place Fontenoy, Paris 7ᵉ, will arrange for the coordination of scientific papers so that the various sections of the program will be properly balanced. Certain specialists have been invited by UNESCO to submit reviews of research on the main subjects of the symposium. These reviews will be circulated beforehand and will serve as an introduction to the work of the various sections.

Members of the symposium wishing to present scientific papers are requested to send the title, together with a summary of not more than 250 words, to UNESCO's Department of Natural Sciences *not later than 1 June 1959.* Only original scientific papers bearing on the program of the various sections will be accepted. The full texts of all scientific papers to be presented orally during the symposium must reach UNESCO *not later than 1 August 1959,* in order to leave sufficient time for reproduction and circulation before the opening of the symposium.

All papers and summaries must be prepared either in English or in French; they will be reproduced only in the original language. Participants who wish to prepare their papers in Spanish are requested to supply an English or French translation.

The Spanish Government has set up an organizing committee responsible, in particular, for making all local arrangements for the reception and accommodation of members of the symposium. The secretary of this committee is Mr. Eladio Asensio, Instituto Nacional de Investigaciones Agronomicas, Avenida de Puerta de Hierro, Madrid.

The symposium will be followed by a study tour in southeastern Spain, organized by the Spanish Department of Agriculture. The organizing committee will in due course supply all particulars regarding this tour.

Forthcoming Events

May

24–27. Chemical Inst. of Canada, 42nd annual conf., Halifax, Nova Scotia. (Chemical Inst. of Canada, 18 Rideau St., Ottawa 2, Ontario.)

24–29. American Tuberculosis Assoc., Chicago, Ill. (Mrs. W. B. White, 1790 Broadway, New York 19.)

24–29. Social Welfare, natl. conf. and annual forum, San Francisco, Calif. (National Conference on Social Welfare, 22 W. Gay St., Columbus 15, Ohio.)

25–27. American Gynecological Soc., Hot Springs, Va. (A. A. Marchetti, 3800 Reservoir Rd., NW, Washington 7.)

25–27. American Soc. for Quality Control, Cleveland, Ohio. (L. S. Eichelberger, A. O. Smith Corp., Milwaukee, Wis.)

25–27. Chemical Inst. of Canada, 42nd annual conf., Halifax, Nova Scotia. (Chemical Inst. of Canada, 18 Rideau St., Ottawa, Ontario, Canada.)

25–27. Telemetering, natl. conf., Denver, Colo. (R. Schmidt, AVCO Mfg. Co., 201 Lowell St., Wilmington, Mass.)

25–28. Smoking and Lung Cancer, and Pulmonary Emphysema, symps., American Trudeau Soc., Chicago, Ill. (H. W. Harris, Medical Sessions Committee, ATS, 1790 Broadway, New York 19.)

25–29. Transistors and Associated Semi-Conductor Devices, intern. conv., London. England. (Institution of Electrical Engineers, Savoy Pl., London, W.C.2.)

25–31. Electroheat, 4th intern. cong., Stresa, Italy. (International Union for Electroheat, 14, rue de Stäel, Paris 15ᵉ, France.)

26–29. American College of Cardiology, Philadelphia, Pa. (P. Reichert, 480 Park Ave., New York 22.)

27–28. Legal Environment of Medical Science, 1st natl. conf. (Natl. Soc. for Medical Research and Univ. of Chicago), Chicago, Ill. (Natl. Soc. for Medical Re-

search, 920 S. Michigan Ave., Chicago 5.)

28–30. American Ophthalmological Soc., Hot Springs, Va. (M. C. Wheeler, 30 W. 59 St., New York 19.)

29–30. International Assoc. for Bronchology, 9th cong., Madrid, Spain. (J. Abello, IAB, Lagascar 13, Spain.)

29–2. Giornate Avicole Varesine (intern. symp.), Varese, Italy. (T. Bonadonna, Univ. of Milan, Milan, Italy.)

30–5. Applications of Atomic Energy to the Petroleum Industry, symp., 5th World Petroleum Congress, New York, N.Y. (C. E. Davis, General Secretary, 5th World Petroleum Congress, 527 Madison Ave., New York 22.)

31–3. Special Libraries Assoc., 50th annual conv., Atlantic City, N.J. (Miss M. E. Lucius, 31 E. 10 St., New York 3.)

31–5. Industrial Research Conf., 10th annual, New York, N.Y. (R. T. Livingston, Director, IRC, 409 Engineering, Columbia Univ., New York 27.)

June

1–3. Evolution, symp., annual, Saskatoon, Saskatchewan, Canada. (Mrs. L. C. Metivier, Royal Soc. of Canada, Natl. Research Bldg., 100 Sussex Drive, Ottawa, Ontario.)

1–4. American Dermatological Assoc., Atlantic City, N.J. (W. M. Sams, 25 Southeast Second Ave., Miami, Fla.)

1–4. Spectroscopy, 10th annual symp., Chicago, Ill. (G. W. Bailey, Borg-Warner Research Center, Des Plaines, Ill.)

1–5. International Silk Assoc., cong., Munich, Germany. (H. Bonvallet, 25, Place Tolozan, Lyon 1, France.)

1–6. International Commission for Northwest Atlantic Fisheries, 9th annual (by invitation), Montreal, Canada. (ICNAF, Forest Bldg., Carlelon St., Halifax, Nova Scotia.)

2–6. American Rheumatism Assoc., Washington, D.C. (E. F. Hartung, 580 Park Ave., New York 21.)

2–6. Rheumatic Diseases, 2nd Pan American cong., Washington, D.C. (R. T. Smith, West Point, Pa.)

3–5. Cellular Aspects of Immunity, symp. (by invitation), Royaumont (near Paris), France. (G. E. W. Wolstenholme, Ciba Foundation, 41 Portland Pl., London, W.1, England.)

3–7. American Assoc. of Bioanalysis, Cincinnati, Ohio. (L. D. Hertert, 490 Post St., Room 1049, San Francisco, 2, Calif.)

3–7. American College of Chest Physicians, Atlantic City, N.J. (M. Kornfeld, 112 E. Chestnut St., Chicago, Ill.)

3–10. Quantitative Biology, symp., 24th, Cold Spring Harbor, N.Y. (M. Demerec, Director, Biological Lab., Cold Spring Harbor, N.Y.)

4. Fine Structure as Related to Absorption, Synthesis and Transport in the Gastrointestinal Tract, symp., Atlantic City, N.J. (E. C. Texter, Gastroenterology Research Group, Medical School, 303 E. Chicago Ave., Northwestern Univ., Chicago 11, Ill.)

4. Petroleum Geochemistry, symp., New York, N.Y. (E. G. Baker, Esso Research and Engineering Co., P.O. Box 51, Linden, N.J.)

4–5. American Geriatrics Soc., Atlantic City, N.J. (R. J. Kraemer, 2907 Post Rd., Warwick, R.I.)

4–6. Endocrine Soc., 41st annual, Atlantic City, N.J. (H. H. Turner, 1200 N. Walker, Oklahoma City, Okla.)

4–7. American Medical Womens Assoc., Atlantic City, N.J. (Miss L. T. Majally, 1790 Broadway, New York 19.)

4–7. American Therapeutic Soc., Atlantic City, N.J. (O. B. Hunter, Jr., 915 19 St., NW, Washington 6.)

4–8. Electrolytes, intern. symp., Trieste, Italy. (Societa Italiana per il Progresso delle Scienze 7, Rome, Italy.)

5–7. American College of Angiology, 5th annual, Atlantic City, N.J. (A. Halpern, 11 Hampton Court, Great Neck, N.Y.)

5–7. American Gastroenterological Assoc., and American Gastroscopic Soc., annual, Atlantic City, N.J. (H. M. Pollard, University Hospital, Ann Arbor, Mich.)

6. American Acad. of Tuberculosis Physicians, Atlantic City, N.J. (O. S. Levin, P.O. Box 7011, Denver 6, Colo.)

6. International Cardiovascular Soc. (North American Chapter), Atlantic City, N.J. (P. T. DeCamp, 3503 Prytania St., New Orleans, La.)

6–7. American Diabetes Assoc., Atlantic City, N.J. (E. Paul Sheridan, 1 E. 45 St., New York 17.)

6–7. Society of Investigative Dermatology, Inc., 20th annual, Atlantic City, N.J. (H. Beerman, 255 S. 17, Philadelphia 3, Pa.)

6, 20, and *27*. Recent Advances in Medical Technology, symp., Staten Island, N.Y. (N. Colosi, Wagner College, Staten Island, N.Y.)

7–11. American Soc. of Heating and Air Conditioning Engineers, semi-annual, Vancouver, B.C., Canada. (A. V. Hutchinson, ASHAE, 62 Worth St., New York 13.)

7–13. Fertility and Sterility, 3rd world cong., Amsterdam, Holland. (W. W. Williams, 20 Magnolia Terrace, Springfield, Mass.)

8–12. American Medical Assoc., Atlantic City, N.J. (F. J. L. Blasingame, 535 N. Dearborn St., Chicago 10, Ill.)

8–12. Association for Research in Ophthalmology, Inc., Atlantic City, N.J. (L. V. Johnson, 10515 Carnegie Ave., Cleveland 6, Ohio.)

9–11. Canadian Federation of Biological Societies (Canadian Physiological Soc., Pharmacological Soc. of Canada, Canadian Assoc. of Anatomists, Canadian Biochemical Soc.), Toronto, Ontario, Canada. (E. H. Bensley, CFBS, Montreal General Hospital, 1650 Cedar Ave., Montreal 25, P.Q.)

9–11. Interferometry, intern. symp., Teddington, England. (Intern. Symp. on Interferometry, Natl. Physical Laboratory, Teddington.)

9–12. Health Technicians, 6th intern. cong., Paris, France. (Secrétariat Général du V^{e} Congrès-Exposition International des Techniciens de la Santé, 37, rue Montholon, Paris 9^{e}.)

10–12. Gas Chromatography, 2nd intern. symp., East Lansing, Mich. (H. S. Kindler, Technical and Educational Services, ISA, 313 Sixth Ave., Pittsburgh 22, Pa.)

(See issue of 17 April for comprehensive list)

New Products

The information reported here is obtained from manufacturers and from other sources considered to be reliable, and it reflects the claims of the manufacturer or other source. Neither Science *nor the writer assumes responsibility for the accuracy of the information. A coupon for use in making inquiries concerning the items listed is included in the postcard insert.*

■ DIGITAL VOLTMETER reads positive and negative d-c voltages from 100 mv to 999 v with automatic selection of range and polarity. Voltages are displayed as three digits with automatic decimal-point placement. Accuracy is ± 0.2 percent of reading ± 1 count. Input impedance to d-c is 11 megohm. Sampling rate is adjustable from 20 per minute to 5 per second and can be externally controlled. (Hewlett-Packard Co., Dept. 738)

■ COINCIDENCE UNIT features direct drive from photomultipliers, input limiting, and ultimate resolution of 3 mμsec with one anticoincidence and three coincidence channels. The coincidence criterion is set by a variable discriminator in a slow channel. All bias and supply potentials are electronically regulated. (E-H Research Laboratories, Dept. 745)

■ IMAGE-CONVERTER CAMERA is designed for use in photographing transient phenomena. The camera is electrostatically focused and deflected. Exposure time ranges from 0.05 to 1 μsec with frame spacing from 0.5 to 50 μsec. Number of frames is selectable from 1 to 5. Resolution at the center of the field ranges from 8 lines per millimeter for exposures from 0.05 to 0.15 μsec to 17 lines per millimeter for steady exposure. Maximum image size at the anode is 25 mm for one to three frames and 15 mm for five frames. Spectral response is maximum at 4000 ± 1000 A. (Librascope, Inc., Dept. 741)

■ PRESSURE SWITCH consists of a contactor manometer and a relay and power supply. Control sensitivity of 0.005-in.-H_2O is achieved by use of manometer fluid of specific gravity 1. Relays operate on 110 v a-c and have double-pole, double-throw switching action. Contact capacity is 5 amp at 115 v a-c. (Meriam Instrument Co., Dept. 746)

■ BLOOD-PRESSURE MONITOR continuously indicates and records systolic blood pressure. Pressure in a digit cuff is maintained at the systolic blood pressure by means of a servomechanism. Pressure up to 300 mm-Hg may be determined. This pressure is continuously indicated on a manometer and can be fed to a pressure recorder if a permanent record is desired. The cuff does not reach completely around the finger, and thus a path for

return of blood to the heart is provided. Timers permit automatic control of duty cycle. The associated recorder is a pen-writing type with 5-in. chart width. Chart speeds are 0.2 and 1 in./min. (Medical Electronics Development Co., Dept. 749)

■ ULTRASONIC IMPACT GRINDER uses a magnetostrictive transducer to permit a 100-percent duty cycle. Materials that can be worked are semiconductors, ferrites, carbides, metals, jewels, and other hard and brittle materials. Cutting force is adjustable. The slurry tray is readily removable, and tool cones are easily interchanged. The ultrasonic driver delivers 100 w. (Raytheon Manufacturing Co., Dept. 750)

■ SCALER SYSTEM offers preset count from 20 to 10^7 and preset time from 0.02 to 1000 min with automatic operation. Scaling operations stop when either preset time or count is reached, whichever occurs first. The system automatically commences a new count after print-out. Any number of units can be used with a single printer; data are read out sequentially. (Radiation Instrument Development Laboratory, Inc., Dept. 755)

■ CARBON ANALYZER is semiautomatic, using a single source of oxygen to burn the sample and to raise and lower the concentration in solutions. The apparatus features replaceable float valves, screw-type zero adjustment, and built-in circulating pump. Operation is on 115-v, 60-cy/sec power. (Laboratory Equipment Corp., Dept. 748)

■ COMPRESSED-GAS REGULATOR features small size: 1 by 2¾ by 3½ in. The regulator, a two-stage device, will handle oxygen, nitrogen, or other gases. Delivered-pressure range is 0 to 90 lb/in². (Beacon Devices, Inc., Dept. 747)

■ VACUUM-GAGE CONTROL provides readings from one ionization and two thermocouple gages covering the range from 1 to 10^{-8} mm-Hg. A protective relay guards the ionization gage against burnout due to pressure surges and permits actuation of warning devices. Ionization emission currents of 1, 5, or 10 ma may be selected. (NRC Equipment Corp., Dept. 754)

■ CURRENT INTEGRATOR accepts input currents in six decade ranges from 0.001 to 100 μa full scale. Integration range varies, with current range, from 1 mμcoul to 10 coul with 100-coul range available on request. Accuracy of current measurement and of charge measurement is ±0.05 percent of reading. Current is amplified by a feedback-stabilized current amplifier. A capacitor integrates the amplifier output to a preset voltage

at which it automatically discharges. The number of discharges and the final charge on the capacitor are recorded. An internal calibration signal, which is applied to the input of the current amplifiers tests for proper operation. (Applied Radiation Corp., Dept. 765)

■ TRIPLE-POINT CELL maintains a reference temperature of 0.01°C by establishing equilibrium between ice, water, and water vapor by partially freezing pure water in an evacuated-and-sealed glass system. Cells are furnished with full instructions for use. (Transonics Inc., Dept. 751)

■ GAUSSMETER is transistorized and designed to operate either on batteries or external power supply. Fields up to 30,000 gauss are measured with indication of direction. No ballistic reading is given. Probe is 0.025 in. thick and has an active area of 0.01 in². (Dyna-Empire, Inc., Dept. 762)

■ VACUUM PUMP for vacuum-distillation applications maintains a pressure of 0.015 mm-Hg with a free-air capacity of 36 lit./min at 540 rev/min. The open-chamber design eliminates freezing and permits solid matter to be exhausted. (Nelson Vacuum Pump Co., Dept. 760)

■ CONTINUOUS-WRITING FRAMING CAMERA operates with no blind time and thus can be used to photograph high-speed events that do not lend themselves to synchronization with the position of the rotating mirror in the camera. Magnification-velocity products up to 3 mm/µsec are accommodated. At conventional magnifications, object velocity can be Mach 35. Daylight loading with standard 35-mm film casettes is provided. (Beckman and Whitley, Inc., Dept. 758)

■ WHITENESS REFLECTOMETER uses paired vacuum tubes in a null bridge circuit. It employs 45 deg–0 deg geometry and has green and blue tristimulus filters, each with a separate pair of phototubes. Separable sections contain the measuring and indicating circuit and the sample viewing system. (Hunter Associates Laboratory Inc., Dept. 752)

■ VIBRATION GENERATORS are available in two models rated at 500 and 150 lb force, respectively. The smaller model allows a bare-table resonance of more than 7000 cy/sec. Bare-table resonance of the larger model is 6000 cy/sec. The generators are of electrodynamic design with dual magnetic field structure producing low stray fields. (Ling Electronics, Inc., Dept. 759)

■ MICROWAVE-FREQUENCY CALIBRATOR generates harmonics up to 25 kMcy/sec. The instrument's 450 Mcy/sec crystal-controlled signal is designed to be fed directly into a waveguide or coaxial crystal holder. A 5-Mcy/sec crystal permits calibration against station WWV. (Micro-Now Instrument Co., Dept. 763)

■ INVERTERS, using static elements, operate from 28-v d-c input and provide output of 115 v at 400 cy and 2000 cy/sec. Regulation characteristics are ±1 percent for voltage and ±0.02 percent for frequency. Distortion is 5 to 10 percent. Weight ranges from 5 to 15 lb. (Gulton Industries, Inc., Dept. 764)

■ MILLIOHMMETER features 13 overlapping ranges measuring 0.001 to 1000 ohm full-scale. Accuracy is ±3 percent of full scale except in the 1-milliohm range, where it is ±5 percent. No calibration or zero adjustments are required. The instrument applies only 2 µw across the circuit under test. (Keithley Instruments Inc., Dept. 756)

■ DIRECT-CURRENT METER has the equivalent of a 63-in. scale with 1000 divisions. This scale is an expansion of the actual 6.3-in. scale effected by a circuit that permits the instrument to cover any 10

percent of full-scale range over a full 6.3-in. scale. The meter is direct-reading. Readability and repeatability are ±0.01 percent. Accuracy is ±0.05 percent of full-scale range. Single-range or switch-controlled multirange models are available. (Sensitive Research Instrument Corp., Dept. 757)

■ HALL GENERATORS allowing multiplication of two electrical quantities feature better than 1-percent linearity over an output range of 100,000 to 1. Units, made of indium arsenide and indium antimonide, are available with external magnetic field coils or in the form of probes. (Device Development Corporation, Dept. 753)

■ TEMPERATURE RECORDER provides a variety of ranges by means of plug-in elements matched to appropriate thermocouples. Automatic reference junction compensation eliminates the need for external temperature reference. Accuracy is ±1 percent of range. Chart width is 5-in., and 1-, 2- and 4-chart-speed models are available. (Varian Associates, Dept. 761)

■ SHAFT-ROTATION-TO-DIGITAL CONVERTER is available in ranges 0 to 999 or 0 to 1999. Coding is accomplished by a disk with read-out brushes not normally in contact. Read-out command places brushes in contact and then energizes the disk. Ambiguity is prevented by a special mechanism. Any type of code can be provided. (Norwood Controls, Dept. 768)

■ HANDLING TOOL for delicate parts is vacuum-operated. A solenoid-operated valve between the vacuum line and the pickup is controlled by a foot-operated switch, by which the operator can release the suction when the part is correctly positioned. Operation is on 115-v, 60-cy/sec power. (Carmen Laboratories, Dept. 766)

■ PULSE GENERATOR produces pulses of controlled amplitude and duration at frequencies from 10 cy to 5.0 Mcy/sec corresponding to the frequency of the input signal. Pulse duration is variable from 0.1 to 5 μsec; rise time is 0.04 μsec and fall time is 0.05 μsec at 40 v output. Amplitude is 2 to 4 v across a 1000-ohm load. Input amplitude must be 3 v r.m.s. or greater. (Technitrol Engineering Company, Dept. 776)

■ GAS CELL for infrared absorption spectrophotometry employs a folded optical path 100 cm long. Sample volume is 950 cm^3. The cell is constructed of cast aluminum with Neoprene gaskets and can contain pressures above or below atmospheric. (Perkin Elmer Corp., Dept. 779)

■ TEMPERATURE CONTROLLER with thermocouple input has a set-point resolution of 0.1 percent of range and handles up to 330 kva through standard saturable reactors. A range selector allows manual switching for temperatures 0° to 800°, 800° to 1800°, and 1800° to 2800°F. In a typical application the controller is said to limit fluctuations to 0.25°F at a temperature of 2200°F. (Hagan Chemicals and Controls Inc., Dept. 777)

■ OPTICAL VIEWER for observation of inaccessible regions features a 180-deg hemispheric field. Lengths up to 40 ft are available. Underwater design, sectional construction, special illumination, and photographic attachments can be provided. Depth of field extending from ¼ in. to infinity is claimed. (Lerma Engineering Corp., Dept. 769)

■ SPECTRUM ANALYZER features r.m.s., average, and peak read-outs. Center frequencies of the analyzer's 30 one-third octave filters range from 40 to 32,000 cy/sec. Filter characteristics are: tops flat within ±0.5 db; sides with maximum slope 120 db per octave; skirt selectivity greater than 50 db per octave and greater than 70 db two octaves from the center frequency. (B & K Instruments, Inc., Dept. 774)

■ PIPETTE PUMP accommodates all sizes of pipettes in rubber-lined chuck jaws. In addition to the large rubber bulb used for filling, a small internal bulb, depressed by a control-knob screw, provides control of micro quantities. The device can be dismantled for cleaning and sterilizing. (Arthur S. LaPine and Co., Dept. 767)

■ SHOCK TESTER develops thrust through differential gas pressure acting on two faces of a thrust piston in a closed cylinder. The cylinder is separated into chambers by an orifice plate. To control the thrust developed, a metering pin attached to the underside of the thrust piston projects through the orifice and meters the flow of gas as a function of piston motion. Maximum thrust of a 3-in. tester is 10,000 lb. (Consolidated Electrodynamics, Dept. 778)

■ STREAKING PIPETTE for setting up paper chromatograms is designed to eliminate drop formation at the tip of the pipette and to maintain a constant hydrostatic head during delivery of the entire sample. Approximately 0.3 ml may be applied by the pipette with one filling. (Research Specialties Co., Dept. 782)

■ RESISTANCE SET consists of 21 resistors scaled in a modified binary-decimal sequence of 1,2,2,4 by decades with an extra units' digit, permitting synthesis of

resistances from 0 to 100,000 ohm in 1-ohm steps. Accuracy and stability of ±0.0015 percent of the maximum value are claimed. An oil bath is used to minimize thermal and self-heating effects. The assembly is housed in a hermetically sealed metal case. (Julie Research Laboratories, Inc., Dept. 780).

■ FLUOROMETER offers sensitivity to as little as 5×10^{-4} μg of quinine sulfate. A range multiplier covers 1:3:10:30 concentration ranges. Neutral-density filters provide additional range multiplication. A single multiplier phototube is used with mechanically chopped radiation of either 2537 or 3600 A. (G. K. Turner Associates, Dept. 770)

■ D-C AMPLIFIER, fully transistorized, has gain of 10 to 10,000. Band width is from d-c to 60,000 cy/sec. Noise level is 6 μv. The amplifier may be used in single-ended or balanced configurations. (Princeton Science Associates, Inc., Dept. 771)

■ THERMOELECTRIC GENERATOR operates with efficiency of about 6 percent. Semiconducting materials are used in the thermoelectric elements. A 5-watt size is intended for use with radioisotope heat source and air cooling. (Minnesota Mining and Manufacturing Co., Dept. 772)

■ CHARTING TOOL is used to place narrow tapes (1/64 to ⅛ in. wide) on charts or graphs. A cutting bar permits the tape to be cut at any point. Tapes are available in 14 solid colors and ten distinct patterns. (Labelon Tape Co., Dept. 773)

■ DIGITAL MILLIVOLTMETER is a self-balancing potentiometer instrument with accuracy of ±0.1 percent. Sensitivity of the basic model is 2.5 μv. Full-scale ranges from 10 mv to 100 v are available. Output of the potentiometer is converted to a three-decade digital indication for continuous visual display. The instrument can be equipped to operate printers, punches, or electric typewriters. Print-out can be made on command, or an optional timer can be supplied to actuate periodic print-out. (Computer Equipment Co., Dept. 781)

■ VACUUM FURNACE reaches temperatures up to 2700°F. Cylindrical radiation shields of heat-resisting alloy are arranged in several concentric shells to insulate the inside walls. Top and bottom have horizontal alloy sheets to form a complete enclosure around material being treated. The furnace casing is water jacketed. (General Electric Co., Dept. 798)

JOSHUA STERN
National Bureau of Standards, Washington, D.C.

PERSONNEL PLACEMENT

CLASSIFIED: Positions Wanted, 25¢ per word, minimum charge $4. Use of box number counts as 10 additional words. Payment in advance is required. **Positions Open,** $33 per inch or fraction thereof. No charge for box number.

COPY for classified ads must reach SCIENCE 2 weeks before date of issue (Friday of every week).

DISPLAY: Rates listed below—no charge for box number. Monthly invoices will be sent on a charge account basis — provided that satisfactory credit is established.

Single insertion	**$33.00 per inch**
4 times in 1 year	**30.00 per inch**
7 times in 1 year	**28.00 per inch**
13 times in 1 year	**27.00 per inch**
26 times in 1 year	**26.00 per inch**
52 times in 1 year	**25.00 per inch**

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

Replies to blind ads should be addressed as follows:
Box (give number)
Science
1515 Massachusetts Ave., NW
Washington 5, D.C.

POSITIONS WANTED

Economic Botanist-Horticulturist-Plant Physiologist; Cornell Ph.D.; teaching, research, and administration; publications. Box 4220, Washington 12, D.C. 4/24

Ph.D., **Organic Chemistry**; since 1945, director of research, pharmaceutical company. Medical Bureau, Burneice Larson, Director, 900 North Michigan Avenue, Chicago. X

POSITIONS WANTED

Biologist, Ph.D., bacteriology: sanitary, pathogenic, agricultural; parasitology, limnology, general botany, or zoology. Box 99, SCIENCE. X

Zoologist, Ph.D. Interested in teaching protozoology, parasitology, genetics, or vertebrate embryology. Combinations of preceding with beginning courses considered. Box 89, SCIENCE. 4/17, 24

POSITIONS OPEN

Biochemist, Ph.D. or M.D., for chief of the biochemistry division of the department of pathology at a large midwestern university and teaching hospital. Excellent opportunity for independent research. Salary over $10,000 depending upon qualifications. Position available September–October, 1959. Curriculum vitae requested. Interview arranged. Box 97, SCIENCE. X

Biochemist, Ph.D., to supervise clinical chemistry in active, well-equipped air-conditioned laboratory of 225-bed hospital. Duties include introducton of new procedures, quality control, participate in intern training and school of medicine technology. Apply Dr. Gary P. Paparo, Pathologist, Memorial Hospital, Pawtucket, Rhode Island. X

Do you want to work in a publishing house concerned with science and economics? You will have to live in Washington. Specifically we need people for promotion and logistics. Box 98, SCIENCE. X

New World-Wide Graduate Award Directories for American scientists, teachers, librarians to subsidize their education and research. Stipends $200–$10,000. Volume I (1957), $3; volume II (just published, no duplication), $3; both volumes, $5. Limited editions. Complete, specific information on 400 awards in United States and overseas in each volume. CRUSADE, Sci., Box 99, Station G, Brooklyn 22, N.Y. eow

POSITIONS OPEN

Chemist, may be an advanced graduate student; 1-year appointment during the absence of a professor on a Fulbright. Salary dependent upon qualifications. Oglethorpe University, Atlanta, Georgia. X

Environmental Physiologist, Ph.D. To teach general animal physiology, comparative physiology, and endocrinology; emphasis on upper division and graduate level; rank of assistant professor. Write immediately for application forms to Professor Loren D. Potter, Chairman, Biology Department, University of New Mexico, Albuquerque, New Mexico. X

Hematologist, Immunologist, with some knowledge of clinical pathology; to take charge small, well-equipped laboratory, 75 percent developmental work. $500 to begin. Swihart Pathology Laboratory, 505 David Whitney Bldg., Detroit 26, Michigan. 4/24; 5/1

Man wanted to cover selected and profitable territory for specialty firm in Midwest. Must have some laboratory background and desire to sell. Products now servicing more than 11,000 laboratories in the United States providing a positive labeling system for laboratories and institutions. Box 60, SCIENCE. 4/10, 24;5/8, 22

(a) **Ph.D. or M.D. Trained in Physiology, Biochemistry or Pharmacology;** duties consist principally investigations in clinical research with rank of associate; one of leading pharmaceutical companies; $12,000–$15,000; East. (b) **Assistant Medical Director;** preferably physician licensed to practice in New York; duties consist of new product development, clinical investigations, assisting advertising agencies, medcal literature, consumer mail; up to $15,000. (c) **Ph.D.'s in Chemistry;** research department concerned with basic to pure research problems and projects formulated by own staff; company expanding its research program; California. S4-4 Medical Bureau, Burneice Larson, Director, 900 North Michigan Avenue, Chicago. X

POSITIONS OPEN

Chemist, Ph.D., liberal arts college. $6000–$7000. Annual raises. Union College, Barbourville, Kentucky. 4/17, 24

Physical Chemist or Chemical Engineer wanted for an appointment as assistant professor. Salary range $6700–$8200. For further details, apply Head, Department of Chemistry, University of Saskatchewan, Saskatoon, Saskatechewan, Canada. X

Research Associate or Graduate Student to assist university Russian language biomedical literature study, New York area. Part- or full-time. Box 90, SCIENCE. 4/24; 5/1, 8

SCIENCE AND ENGINEERING AT ROBERT COLLEGE OF ISTANBUL

Opportunities for qualified men in engineering, mathematics, physics and chemistry interested in combining teaching and consulting with opportunity to live and travel in vital area. Development program is in effect to strengthen staff, modernize undergraduate curricula, inaugurate graduate program, construct new science and engineering building, prepare engineers for the industrial and technological development of Turkey and the Middle East.

Address inquiries to Dr. Duncan S. Ballantine, President, or Dean Howard P. Hall of the College of Engineering at Robert College, Bebek P.K. 8, Istanbul, Turkey with copy to the Near East College Association, 40 Worth Street, New York 13, New York.

SCIENCE TEACHERS, LIBRARIANS, ADMINISTRATORS urgently needed for positions in many states and foreign lands. Monthly non-fee placement journal since 1952 gives complete job data, salaries. Members' qualifications and vacancies listed free. 1 issue, $1.00. Yearly (12 issues) membership, $5.00. CRUSADE, SCI., Box 99, Station G, Brooklyn 22, N.Y. ew

SENIOR SCIENTIFIC WRITER

Pharmacologist with good chemical background and demonstrated writing ability to fill an available position. This is an opportunity to do interpretive writing with a minimum of guidance. It requires a person with solid experimental experience, and inquisitive mind, interest in semantical problems, ability to work with a group, and a demonstrated capacity with written expression. Write, stating qualifications and salary desired, to Personnel Department

WYETH

Box 8299 Philadelphia 1, Pa.

The Soil and Health Foundation, Emmaus, Pennsylvania, invites applications for the position of research supervisor. Research is to be carried out in the fields of soil studies, plant breeding, and the nutritive value of agricultural crops. Salary open. Apply in writing giving academic qualifications and experience. X

The Market Place

BOOKS • SERVICES • SUPPLIES • EQUIPMENT

DISPLAY: Monthly invoices will be sent on a charge account basis—provided that satisfactory credit is established.

Single insertion	$33.00 per inch
4 times in 1 year	30.00 per inch
7 times in 1 year	28.00 per inch
13 times in 1 year	27.00 per inch
26 times in 1 year	26.00 per inch
52 times in 1 year	25.00 per inch

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

BOOKS AND MAGAZINES

SCIENTIFIC JOURNALS WANTED

Sets, Runs and Volumes bought at top prices. Your wants supplied from our Back Files of over 3,000,000 periodicals. **Abrahams Magazine Service; N. Y. 3, N. Y.**

BOOKS AND MAGAZINES

Your sets and files of scientific journals

are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. Write Dept. A3S, CANNER'S, Inc. Boston 20, Massachusetts

SUPPLIES AND EQUIPMENT

THE JUNIOR
Gorceau
Electroencephalograph
Price $575.00 complete.
No Batteries
Requires no Shielding
Prompt Delivery
A.C. Operated
Inkless Writing
Shipped Ready to Run

ELECTRO-MEDICAL LABORATORY, INC.
South Woodstock 2, Vermont

PROFESSIONAL SERVICES

LABORATORY SERVICES for the FOOD and DRUG INDUSTRIES
Drug Evaluation, Food Additive Studies, Chemical and Biological Assays, Clinical Studies, Research

LaWALL & HARRISSON
Div. S, 1921 Walnut St., Philadelphia 3, Pa. RI 6-4322

26th WRITERS' CONFERENCE in the Rocky Mountains
JULY 20 to AUGUST 7
Outstanding staff, including Harold Walton, A. B. Guthrie, Jr., Walker Gibson, Stewart Holbrook, William Peden, Ellingwood Kay, Shannon Garst, and Virginia Sorensen. Write Margaret Robb, Director, McKenna 43, University of Colorado, Boulder, Colorado.

FOUNDED 1922
Food and Drug Research Laboratories
INCORPORATED
Maurice Avenue at 58th Street
Maspeth 78, New York City
CABLE: FOODLABS TEL. TWINING 4-0800

AUTHORS! ATTENTION!
Should our editors approve your MS, our cooperative contract offers many advantages. All subjects considered. Scientific and technical book manuscripts especially welcome.
Send your book manuscript to
CLAYTON PRESS, Att.: Mr. Jones
507 Fifth Ave., N.Y. 17, N.Y.

WISCONSIN ALUMNI RESEARCH FOUNDATION
LABORATORY SERVICES
for the FOOD, FEED, DRUG and CHEMICAL INDUSTRIES
Analyses, Biological Evaluation, Toxicity Studies, Insecticide Testing and Screening, Flavor Evaluation.
Project Research and Consultation
Write for Price Schedule
P. O. Box 2217 • Madison 1, Wis.

HISTOLOGY for Industry and Research
GEORGE L. ROZSA, M.D.
143 Linwood Ave. Buffalo 9, New York
GRant 7165

ANTIMETABOLITES AND CANCER

AAAS Symposium Volume

6" x 9", 318 pp., 54 illus., clothbound, 1955
Price $5.75

AAAS Members' prepaid price $5.00

"This volume presents the great variety of techniques and disciplines being brought to bear on the problem of cancer therapy and the vitality of the chemotherapeutic approach to cancer. This is an important book and merits the careful consideration of cancer investigators, biochemists, pharmacologists and general biologists."
Cancer, Jan-Feb 1956.

"All who are concerned with the problems of chemotherapy in malignant disease and those who wish to broaden their knowledge of the challenging subject of antimetabolites will find a wealth of information in this edition. . . .

"The text is clearly written and readily understandable by those who have a good working knowledge of biology and chemistry and are familiar with terms which are currently used in the medical sciences; it is particularly recommended to the attention of those engaged in research, teaching, and treatment of cancer, and in study of the problems of growth." *American Journal of Public Health*, Feb 1956.

American Association for the Advancement of Science
1515 Mass. Ave., NW
Washington 5, D.C.